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Application
for
United States Letters Patent

To all whom it may concern:

Be it known that Leslie B. Vosshall, et al.

have invented certain new and useful improvements in
GENES ENCODING INSECT ODORANT RECEPTORS AND USES THEREOF

of which the following is a full, clear and exact description.

GENES ENCODING INSECT ODORANT RECEPTORS AND USES THEREOF

This application claims priority and is a continuation-in-part application of U.S. Serial No. 09/257,706, filed February 25, 1999, the contents of which is hereby incorporated by reference.

The invention disclosed herein was made with Government support under NIH:NIMH, 5P50, MH50733-05 and the NINDS, NS29832-07 from the Department of Health and Human Services. Accordingly, the U.S. Government has certain rights in this invention.

Throughout this application, various publications are referred to by arabic numeral within parentheses. Full citations for these publications are presented immediately before the claims. Disclosures of these publications in their entireties are hereby incorporated by reference into this application in order to more fully describe the state of the art to which this invention pertains.

BACKGROUND OF THE INVENTION

All animals possess a "nose," an olfactory sense organ that allows for the recognition and discrimination of chemosensory information in the environment. Humans, for example, are thought to recognize over 10,000 discrete odors with exquisite discriminatory power such that subtle differences in chemical structure can often lead to profound differences in perceived odor quality. What mechanisms have evolved to allow the recognition and discrimination of complex olfactory information and how is olfactory perception ultimately translated into appropriate behavioral responses? The recognition of odors is accomplished by odorant receptors that reside on olfactory cilia, a specialization of the dendrite of the olfactory sensory neuron. The odorant receptor genes encode novel serpentine receptors that traverse the membrane seven times. In several vertebrate species, and in the invertebrate Caenorhabditis elegans, as

many as 1000 genes encode odorant receptors, suggesting that 1-5% of the coding potential of the genome in these organisms is devoted to the recognition of olfactory sensory stimuli (Buck and Axel, 1991; Levy et al., 1991; Parmentier et al., 1992; Ben-Arie et al., 1994; Troemel et al., 1995; Sengupta et al., 1996; Robertson, 1998). Thus, unlike color vision in which three photoreceptors can absorb light across the entire visible spectrum, these data suggest that a small number of odorant receptors are insufficient to recognize the full spectrum of distinct molecular structures perceived by the olfactory system. Rather, the olfactory sensory system employs an extremely large number of receptors, each capable of recognizing a small number of odorous ligands.

The discrimination of olfactory information requires that the brain discern which of the numerous receptors have been activated by an odorant. In mammals, individual olfactory sensory neurons express only one of a thousand receptor genes such that the neurons are functionally distinct (Ngai et al., 1993; Ressler et al., 1993; Vassar et al., 1993; Chess et al., 1994; Dulac and Axel, unpublished). The axons from olfactory neurons expressing a specific receptor converge upon two spatially invariant glomeruli among the 1800 glomeruli within the olfactory bulb (Ressler et al., 1994; Vassar et al., 1994; Mombaerts et al., 1996; Wang et al., 1998). The bulb therefore provides a spatial map that identifies which of the numerous receptors has been activated within the sensory epithelium. The quality of an olfactory stimulus would therefore be encoded by specific combinations of glomeruli activated by a given odorant.

The logic of olfactory discrimination is quite different in the nematode, C. elegans. Despite the large size of the odorant receptor gene family, volatile odorants are recognized by only three pairs of chemosensory cells each likely to express a large number of receptor genes (Bargmann and Horvitz, 1991; Colbert and Bargmann, 1995; Troemel et al., 1995). Activation of any one of the multiple receptors

in one cell will lead to chemoattraction, whereas activation of receptors in a second cell will result in chemorepulsion (Troemel et al., 1997). The specific neural circuit activated by a given sensory neuron is therefore the determinant of the behavioral response. Thus, this invertebrate olfactory sensory system retains the ability to recognize a vast array of odorants but has only limited discriminatory power.

Vertebrates create an internal representation of the external olfactory world that must translate stimulus features into neural information. Despite the elucidation of a precise spatial map, it has been difficult in vertebrates to discern how this information is decoded to relate the recognition of odors to specific behavioral responses. Genetic analysis of olfactory-driven behavior in invertebrates may ultimately afford a system to understand the mechanistic link between odor recognition and behavior. Insects provide an attractive model system for studying the peripheral and central events in olfaction because they exhibit sophisticated olfactory-driven behaviors under control of an olfactory sensory system that is significantly simpler anatomically than that of vertebrates (Siddiqi, 1987; Carlson, 1996). Olfactory-based associative learning, for example, is robust in insects and results in discernible modifications in the neural representation of odors in the brain (Faber et al., 1998). It may therefore be possible to associate modifications in defined olfactory connections with *in vivo* paradigms for learning and memory.

Olfactory recognition in the fruit fly Drosophila is accomplished by sensory hairs distributed over the surface of the third antennal segment and the maxillary palp. Olfactory neurons within sensory hairs send projections to one of 43 glomeruli within the antennal lobe of the brain (Stocker, 1994; Laissue et al, 1999). The glomeruli are innervated by dendrites of the projection neurons, the insect equivalent of the mitral cells in the vertebrate olfactory bulb, whose cell bodies surround the glomeruli. These antennal lobe neurons in turn project to the mushroom body

and lateral horn of the protocerebrum (reviewed in Stocker, 1994). 2-deoxyglucose mapping in the fruit fly (Rodrigues, 1988) and calcium imaging in the honeybee (Joerges et al., 1997; Faber et al., 1998) demonstrate that different odorants elicit defined patterns of glomerular activity, suggesting that in insects as in vertebrates, a topographic map of odor quality is represented in the antennal lobe. However, in the absence of the genes encoding the receptor molecules, it has not been possible to define a physical basis for this spatial map.

In this study, we identify a large family of genes that are likely to encode theodorant receptors of Drosophila melanogaster. Difference cloning, along with analysis of Drosophila genomic sequences, has led to the identification of a novel family of putative seven transmembrane domain receptors likely to be encoded by 100 to 200 genes within the Drosophila genome. Each receptor is expressed in a small subset of sensory cells (0.5-1.5%) that is spatially defined within the antenna and maxillary palp. Moreover, different neurons express distinct complements of receptor genes such that individual neurons are functionally distinct. Identification of a large family of putative odorant receptors in insects indicates that, as in other species, the diversity and specificity of odor recognition is accommodated by a large family of receptor genes. The identification of the family of putative odorant receptor genes may afford insight into the logic of olfactory perception in Drosophila.

Insects provide an attractive system for the study of olfactory sensory perception. We have identified a novel family of seven transmembrane domain proteins, encoded by 100 to 200 genes, that is likely to represent the family of Drosophila odorant receptors. Members of this gene family are expressed in topographically defined subpopulations of olfactory sensory neurons in either the antenna or the maxillary palp. Sensory neurons express different complements of receptor genes, such that individual neurons are

functionally distinct. The isolation of candidate odorant receptor genes along with a genetic analysis of olfactory-driven behavior in insects may ultimately afford a system to understand the mechanistic link between odor recognition and behavior.

SUMMARY OF THE INVENTION

This invention provides an isolated nucleic acid molecule encoding an insect odorant receptor. In an embodiment, the isolated nucleic acid molecule comprise: (a) one of the nucleic acid sequences as set forth in Figure 8, (b) a sequence being degenerated to a sequence of (a) as a result of the genetic code; or (c) a sequence encoding one of the amino acid sequences as set forth in Figure 8.

This invention provides a nucleic acid molecule of at least 12 nucleotides capable of specifically hybridizing with the sequence of the above-described nucleic acid molecule. This invention provides a vector which comprises the above-described isolated nucleic acid molecule. In another embodiment, the vector is a plasmid.

This invention also provides a host vector system for the production of a polypeptide having the biological activity of an insect odorant receptor which comprises the above described vector and a suitable host.

This invention provides a method of producing a polypeptide having the biological activity of an insect odorant receptor which comprising growing the above described host vector system under conditions permitting production of the polypeptide and recovering the polypeptide so produced.

This invention also provides a purified, insect odorant receptor. This invention further provides a polypeptide encoded by the above-described isolated nucleic acid molecule.

This invention provides an antibody capable of specifically binding to an insect odorant receptor. This invention also provides an antibody capable of competitively inhibiting the binding of the antibody capable of specifically binding to an insect odorant receptor.

This invention provides a method for identifying cDNA inserts encoding an insect odorant receptors comprising: (a) generating a cDNA library which contains clones carrying cDNA inserts from antennal or maxillary palp sensory neurons; (b) hybridizing nucleic acid molecules of the clones from the cDNA libraries generated in step (a) with probes prepared from the antenna or maxillary palp neurons and probes from heads lacking antenna or maxillary palp neurons or from virgin female body tissue; (c) selecting clones which hybridized with probes from the antenna or maxillary palp neurons but not from head lacking antenna or maxillary palp neurons or virgin female body tissue; and (d) isolating clones which carry the hybridized inserts, thereby identifying the inserts encoding odorant receptors.

This invention also provides cDNA inserts identified by the above method.

This invention further provides a method for identifying DNA inserts encoding an insect odorant receptors comprising: (a) generating DNA libraries which contain clones carrying inserts from a sample which contains at least one antennal or maxillary palp neuron; (b) contacting clones from the cDNA libraries generated in step (a) with nucleic acid molecule capable of specifically hybridizing with the sequence which encodes an insect odorant receptor in appropriate conditions permitting the hybridization of the nucleic acid molecules of the clones and the nucleic acid molecule; (c) selecting clones which hybridized with the nucleic acid molecule; and (d) isolating the clones which carry the hybridized inserts, thereby identifying the inserts encoding the odorant receptors.

This invention also provides a method to identify DNA inserts encoding an insect odorant receptors comprising:
(a) generating DNA libraries which contain clones with inserts from a sample which contains at least one antenna or maxillary palp sensory neuron; (b) contacting the clones from

the DNA libraries generated in step (a) with appropriate polymerase chain reaction primers capable of specifically binding to nucleic acid molecules encoding odorant receptors in appropriate conditions permitting the amplification of the hybridized inserts by polymerase chain reaction; (c) selecting the amplified inserts; and (d) isolating the amplified inserts, thereby identifying the inserts encoding the odorant receptors.

This invention also provides a method to isolate DNA molecules encoding insect odorant receptors comprising: (a) contacting a biological sample known to contain nucleic acids with appropriate polymerase chain reaction primers capable of specifically binding to nucleic acid molecules encoding insect odorant receptors in appropriate conditions permitting the amplification of the hybridized molecules by polymerase chain reaction; (b) isolating the amplified molecules, thereby identifying the DNA molecules encoding the insect odorant receptors.

This invention also provides a method of transforming cells which comprises transfecting a host cell with a suitable vector described above. This invention also provides transformed cells produced by the above method.

This invention provides a method of identifying a compound capable of specifically bind to an insect odorant receptor which comprises contacting a transfected cells or membrane fractions of the above described transfected cells with an appropriate amount of the compound under conditions permitting binding of the compound to such receptor, detecting the presence of any such compound specifically bound to the receptor, and thereby determining whether the compound specifically binds to the receptor.

This invention provides a method of identifying a compound capable of specifically binding to an insect odorant receptor which comprises contacting an appropriate amount of the

purified insect odorant receptor with an appropriate amount of the compound under conditions permitting binding of the compound to such purified receptor, detecting the presence of any such compound specifically bound to the receptor, and thereby determining whether the compound specifically binds to the receptor.

This invention also provides a method of identifying a compound capable of activating the activity of an insect odorant receptor which comprises contacting the transfected cells or membrane fractions of the above-described transfected cells with the compound under conditions permitting the activation of a functional odorant receptor response, the activation of the receptor indicating that the compound is capable of activating the activity of a odorant receptor.

This invention also provides a method of identifying a compound capable of activating the activity of an odorant receptor which comprises contacting a purified insect odorant receptor with the compound under conditions permitting the activation of a functional odorant receptor response, the activation of the receptor indicating that the compound is capable of activating the activity of a odorant receptor. In an embodiment, the purified receptor is embedded in a lipid bilayer.

This invention also provides a method of identifying a compound capable of inhibiting the activity of a odorant receptor which comprises contacting the transfected cells or membrane fractions of the above-described transfected cells with an appropriate amount of the compound under conditions permitting the inhibition of a functional odorant receptor response, the inhibition of the receptor response indicating that the compound is capable of inhibiting the activity of a odorant receptor.

This invention provides a method of identifying a compound capable of inhibiting the activity of a odorant receptor which comprises contacting an appropriate amount of the purified insect odorant receptor with an appropriate amount of the compound under conditions permitting the inhibition of a functional odorant receptor response, the inhibition of the receptor response indicating that the compound is capable of activating the activity of a odorant receptor. In an embodiment, the purified receptor is embedded in a lipid bilayer.

This invention also provides the compound identified by the above-described methods.

This invention provides a method of controlling pest populations which comprises identifying odorant ligands by the above-described method which are alarm odorant ligands and spraying the desired area with the identified odorant ligands.

Finally, this invention provides a method of controlling a pest population which comprises identifying odorant ligands by the above-described method which interfere with the interaction between the odorant ligands and the odorant receptors which are associated with fertility.

BRIEF DESCRIPTION OF FIGURES

FIGURE 1 **Identification of Rare Antennal- and Maxillary Palp-Specific Genes**

Candidate antennal/maxillary palp-specific phage were subjected to *in vivo* excision, digestion of resulting pBLUESCRIPT plasmid DNAs with BamHI/Asp718, and electrophoresis on 1.5% agarose gels. Southern blots were hybridized with ^{32}P-labeled cDNA probes generated from antennal/maxillary palp mRNA (Panel A), head minus antennal/maxillary palp mRNA (Panel B), or virgin female body mRNA (Panel C). The ethidium bromide stained gel is shown in Panel D. Of the thirteen clones displayed in this figure, four appear to be antennal/maxillary palp specific (lanes 5, 7, 9, and 11). However, only two are selectively expressed in subsets of cells in chemosensory organs of the adult fly. DOR104, a putative maxillary palp odorant receptor, is in Lane 9. The clone in Lane 11 (RN106) is homologous to lipoprotein and triglyceride lipases and is expressed in a restricted domain in the antenna (data not shown).

FIGURE 2 **Expression of DOR104 in a Subset of Maxillary Palp Neurons**

(A) A frontal section of an adult maxillary palp was hybridized with a digoxigenin-labeled antisense RNA probe and visualized with anti-digoxigenin conjugated to alkaline phosphatase. Seven cells expressing DOR104 are visible in this 15 μm section, which represents about one third of the diameter of the maxillary palp. Serial sections of multiple maxillary palps were scored for DOR104 expression and on average 20 cells per maxillary palp are positive for this receptor.

(B) Transgenic flies carrying a DOR104-lacZ reporter transgene were stained with X-GAL in a whole mount preparation. Maxillary palps were dissected from the head and viewed in a flattened cover slipped preparation under Nomarski optics, which allows the visualization of all 20 cells expressing DOR104-lacZ.

(C) Dendrites and axons of neurons expressing DOR104-lacZ are visible in this horizontal section of a maxillary palp. LacZ expression was visualized with a polyclonal anti-ß-galactosidase primary antibody and a CY3-conjugated secondary antibody. Sections were viewed under epifluorescence and photographed on black and white film.

FIGURE 3 **Predicted Amino Acid Sequences of Drosophila Odorant Receptor Genes**

Deduced amino acid sequences of 12 DOR genes are aligned using ClustalW (MacVector, Oxford Molecular). Predicted positions of transmembrane regions (I-VII) are indicated by bars above the alignment. Amino acids identities are marked with dark shading and similarities are indicated with light shading. Protein sequences of DOR87, 53, 67, 104, and 64 were derived from cDNA clones. All others were derived from GENSCAN predictions of intron-exon arrangements in genomic DNA, as indicated by the letter "g" after the gene name. We obtained a partial cDNA clone for DOR62 and found it to be 100% identical to the GENSCAN protein in the region of amino acids 245-381. A 40 amino acid extension for DOR 19 was predicted by GENSCAN analysis. This has been replaced with an asterisk in the alignment, and isolation of cDNA clones for this receptor will resolve whether this extension is physically present in the protein.

FIGURE 4 **Receptor Gene Expression in Spatially Restricted Regions of the Antenna**

Digoxigenin-labeled antisense RNA probes against 8 DOR genes each hybridize to a small number of cells distributed in distinct regions in the antenna. The total number of cells per antenna expressing a given receptor was obtained by counting positive cells in serial sections of multiple antennae. There are approximately 20 positive cells per antenna for DOR67 (A), 53 (B), and 24 (data not shown); 15 positive cells for DOR62 (C) and 87 (D); and 10 positive cells for DOR64 (E). The actual number of cells staining in these sections is a subset of this total number. With the exception of DOR53 and DOR67, which strongly cross-hybridize, the receptor genes likely identify different olfactory neurons, such that the number of cells staining with a mixed probe (F) is equal to the sum of those staining with the individual probes (A-E). The mixture of DOR53, 67, 62, 87 and 64 labels a total of about 60 cells per antenna. A total of 34 cells stain with the mixed probe in this 15 μm section. Expression of the linked genes DOR71, DOR72, and DOR73 is shown in panels (G), (H), and (I), respectively. DOR71 is expressed in approximately 10 cells in the maxillary palp. Five positive cells are seen in the horizontal section in panel (G). We also examined the expression of the other members of this linkage group and found DOR72 in approximately 15 cells (of which 3 label in this section) (H) and DOR73 in 1 to 2 cells per antenna (I).

FIGURE 5 **Odorant Receptors are Restricted to Distinct Populations of Olfactory Neurons**

(A-C) Flies of the C155 *elav*-GAL4; UAS-lacZ genotype express cytoplasmic lacZ in all neuronal cells. Panels (A-C) show confocal images of a horizontal maxillary palp section from such a fly incubated with an antisense RNA probe against DOR104 (red) and anti-ß-galactosidase antibody (green). DOR104 recognizes five cells in this maxillary palp section (A), all of which also express *elav*-lacZ (B), as demonstrated by the yellow cells in the merged image in panel ©).

(D, E) DOR64 and DOR87 are expressed in non-overlapping neurons at the tip of the antenna. Antisense RNA probes for DOR64 (digoxigenin-RNA; red) and DOR87 (FITC-RNA; green) were annealed to the same antennal sections and viewed by confocal microscopy. Panel (D) is a digital superimposition of confocal images taken at 0.5 μm intervals through a 10 μm section of the antenna. Cells at different focal planes express both receptors, but no double labeled cells are found.

(F, G) Two color RNA *in situ* hybridization with odorant receptors and odorant binding proteins demonstrates that these proteins are expressed in different populations of cells. DOR53 (FITC-RNA; green) labels a few cells internal to the cuticle at the proximal-medial edge, while PBPRP2 (digoxigenin-RNA; red) labels a large number of cells apposed to the cuticle throughout the antenna (F). The more restricted odorant binding protein OS-F (digoxigenin-RNA; red) also stains cells distinct from those expressing DOR67 (FITC-RNA; green) (G).

FIGURE 6 **Receptor Expression is Conserved Between Individuals**

Frontal sections of antennae from six different individuals were hybridized with

digoxigenin-labeled antisense RNA probes against DOR53 (A-C) or DOR87 (D-F). DOR53 labels approximately 20 cells on the proximal-medial edge of the antenna, of which approximately 5 are shown labeling in these sections. DOR87 is expressed in about the same number of cells at the distal tip. Both the position and number of staining cells is conserved between different individuals and is not sexually dimorphic.

FIGURE 7 **Drosophila Odorant Receptors are Highly Divergent**

Oregon R genomic DNA isolated from whole flies was digested with BamHI (B), EcoRI (E), or HindIII (H), electrophoresed on 0.8% agarose gels, and blotted to nitrocellulose membranes. Blots were annealed with ^{32}P-labeled probes derived from DOR53 cDNA (A), DOR67 cDNA (B), or DNA fragments generated by RT-PCR from antennal mRNA for DOR 24 (C), DOR62 (D), and DOR72 (E). Strong crosshybridization of DOR53 and DOR67 is seen at both high and low stringency (A, B), while DOR24, 62, and 72 reveal only a single hybridizing band in each lane at both low stringency (C-E) and high stringency (data not shown).

FIGURE 8 **DOR 62, 104, 87, 53, 67, 64, 71g, 72g, 73g, 46, 19g, and 24g**

Both nucleic acid sequence of each DOR and its encoded amino acid sequence are described.

FIGURE 9 Analysis of axonal projections of olfactory receptor neurons expressing a given *Drosophila* odorant receptor. Result: all neurons expressing a given receptor send their axons to a single glomerulus, or discrete synaptic structure, in the olfactory processing center of the fly brain. This result is identical to that obtained with

mouse odorant receptors: each glomerulus is dedicated to receiving axonal input from neurons expressing a given odorant receptor. Therefore, this result strengthens the argument that these genes indeed function as odorant receptors in *Drosophila*.

FIGURE 10 **ClustalW alignments of two subfamilies of the *Drosophila* odorant receptors, the DOR53 (A-1 and A-2) and DOR64 (B) families.** This figure highlights sequence similarities between DOR genes, that are diagnostic hallmarks of the proteins. Residues that are identical in different DOR genes are highlighted in black, while residues that are similar are highlighted in gray.

DETAILED DESCRIPTION OF THE INVENTION

In order to facilitate an understanding of the Experimental Procedures section which follow, certain frequently occurring methods and/or terms are described in Sambrook, et al. (1989).

Throughout this application, the following standard abbreviations are used throughout the specification to indicate specific nucleotides:

C=cytosine	A=adenosine
T=thymidine	G=guanosine

This invention provides an isolated nucleic acid molecule encoding an insect odorant receptor. The nucleic acid includes but is not limited to DNA, cDNA, genomic DNA, synthetic DNA or RNA. In an embodiment, the nucleic acid molecule encodes a Drosophila odorant receptor.

In a further embodiment, the isolated nucleic acid molecule comprise: (a) one of the nucleic acid sequences as set forth in Figure 8, (b) a sequence being degenerated to a sequence of (a) as a result of the genetic code; or (c) a sequence encoding one of the amino acid sequences as set forth in Figure 8.

The nucleic acid molecules encoding a insect receptor includes molecules coding for polypeptide analogs, fragments or derivatives of antigenic polypeptides which differ from naturally-occurring forms in terms of the identity or location of one or more amino acid residues (deletion analogs containing less than all of the residues specified for the protein, substitution analogs wherein one or more residues specified are replaced by other residues and addition analogs where in one or more amino acid residues is added to a terminal or medial portion of the polypeptides) and which share some or all properties of naturally-occurring forms.

These molecules include but not limited to: the incorporation of codons "preferred" for expression by selected non-mammalian hosts; the provision of sites for cleavage by restriction endonuclease enzymes; and the provision of additional initial, terminal or intermediate sequences that facilitate construction of readily expressed vectors. Accordingly, these changes may result in a modified insect odorant receptor. It is the intent of this invention to include nucleic acid molecules which encodes modified insect odorant receptor. Also, to facilitate the expression of receptor in different host cells, it may be necessary to modify the molecule such that the expressed receptors may reach the surface of the host cells. The modified insect odorant receptor should have biological activities similar to the unmodified insect odorant receptor. The molecules may also be modified to increase the biological activity of the expressed receptor.

This invention provides a nucleic acid molecule of at least 12 nucleotides capable of specifically hybridizing with the sequence of the above-described nucleic acid molecule. In an embodiment, the nucleic acid molecule hybridizes with a unique sequence within the sequence of the above-described nucleic acid molecule. This nucleic acid molecule may be DNA, cDNA, genomic DNA, synthetic DNA or RNA.

This invention provides a vector which comprises the above-described isolated nucleic acid molecule. In another embodiment, the vector is a plasmid.

In an embodiment, the above described isolated nucleic acid molecule is operatively linked to a regulatory element.

Regulatory elements required for expression include promoter sequences to bind RNA polymerase and transcription initiation sequences for ribosome binding. For example, a bacterial expression vector includes a promoter such as the lac promoter and for transcription initiation the Shine-Dalgarno

sequence and the start codon AUG. Similarly, a eukaryotic expression vector includes a heterologous or homologous promoter for RNA polymerase II, a downstream polyadenylation signal, the start codon AUG, and a termination codon for detachment of the ribosome. Such vectors may be obtained commercially or assembled from the sequences described by methods well-known in the art, for example the methods described above for constructing vectors in general.

This invention also provides a host vector system for the production of a polypeptide having the biological activity of an insect odorant receptor which comprises the above described vector and a suitable host.

This invention also provides a host vector system, wherein the suitable host is a bacterial cell, yeast cell, insect cell, or animal cell. The host cell of the above expression system may be selected from the group consisting of the cells where the protein of interest is normally expressed, or foreign cells such as bacterial cells (such as *E. coli*), yeast cells, fungal cells, insect cells, nematode cells, plant or animal cells, where the protein of interest is not normally expressed. Suitable animal cells include, but are not limited to Vero cells, HeLa cells, Cos cells, CV1 cells and various primary mammalian cells.

This invention provides a method of producing a polypeptide having the biological activity of an insect odorant receptor which comprising growing the above described host vector system under conditions permitting production of the polypeptide and recovering the polypeptide so produced.

This invention also provides a purified, insect odorant receptor. This invention further provides a polypeptide encoded by the above-described isolated nucleic acid molecule.

This invention provides an antibody capable of specifically binding to an insect odorant receptor. This invention also provides an antibody capable of competitively inhibiting the binding of the antibody capable of specifically binding to an insect odorant receptor. In an embodiment, the antibody is monoclonal. In another embodiment, the antibody is polyclonal.

Monoclonal antibody directed to an insect odorant receptor may comprise, for example, a monoclonal antibody directed to an epitope of an insect odorant receptor present on the surface of a cell. Amino acid sequences may be analyzed by methods well known to those skilled in the art to determine whether they produce hydrophobic or hydrophilic regions in the proteins which they build. In the case of cell membrane proteins, hydrophobic regions are well known to form the part of the protein that is inserted into the lipid bilayer which forms the cell membrane, while hydrophilic regions are located on the cell surface, in an aqueous environment.

Antibodies directed to an insect odorant receptor may be serum-derived or monoclonal and are prepared using methods well known in the art. For example, monoclonal antibodies are prepared using hybridoma technology by fusing antibody producing B cells from immunized animals with myeloma cells and selecting the resulting hybridoma cell line producing the desired antibody. Cells such as NIH3T3 cells or 293 cells which express the receptor may be used as immunogens to raise such an antibody. Alternatively, synthetic peptides may be prepared using commercially available machines.

As a still further alternative, DNA, such as a cDNA or a fragment thereof, encoding the receptor or a portion of the receptor may be cloned and expressed. The expressed polypeptide recovered and used as an immunogen.

The resulting antibodies are useful to detect the presence of insect odorant receptors or to inhibit the function of the

receptor in living animals, in humans, or in biological tissues or fluids isolated from animals or humans.

This antibodies may also be useful for identifying or isolating other insect odorant receptors. For example, antibodies against the Drosophila odorant receptor may be used to screen an cockroach expression library for a cockroach odorant receptor. Such antibodies may be monoclonal or monospecific polyclonal antibody against a selected insect odorant receptor. Different insect expression libraries are readily available and may be made using technologies well-known in the art.

One means of isolating a nucleic acid molecule which encodes an insect odorant receptor is to probe a libraries with a natural or artificially designed probes, using methods well known in the art. The probes may be DNA or RNA. The library may be cDNA or genomic DNA.

This invention provides a method for identifying cDNA inserts encoding an insect odorant receptors comprising: (a) generating a cDNA library which contains clones carrying cDNA inserts from antennal or maxillary palp sensory neurons; (b) hybridizing nucleic acid molecules of the clones from the cDNA libraries generated in step (a) with probes prepared from the antenna or maxillary palp neurons and probes from heads lacking antenna or maxillary palp neurons or from virgin female body tissue; (c) selecting clones which hybridized with probes from the antenna or maxillary palp neurons but not from head lacking antenna or maxillary palp neurons or virgin female body tissue; and (d) isolating clones which carry the hybridized inserts, thereby identifying the inserts encoding odorant receptors.

In an embodiment of the above method, after step (c), it further comprises: (a) amplifying the inserts from the selected clones by polymerase chain reaction; (b) hybridizing the amplified inserts with probes from the antennal or

maxillary palp neurons; and (c) isolating the clones which carry the hybridized inserts, thereby identifying the inserts encoding the odorant receptors.
In an embodiment, the probes are cDNA probes.

The appropriate polymerase chain reaction primers may be chosen from the conserved regions of the known insect odorant receptor sequences. Alternatively, the primers may be chosen from the regions which are the active sites for the binding of ligands.

This invention also provides cDNA inserts identified by the above method.

This invention further provides amethod for identifying DNA inserts encoding an insect odorant receptors comprising: (a) generating DNA libraries which contain clones carrying inserts from a sample which contains at least one antennal or maxillary palp neuron; (b) contacting clones from the cDNA libraries generated in step (a) with nucleic acid molecule capable of specifically hybridizing with the sequence which encodes an insect odorant receptor in appropriate conditions permitting the hybridization of the nucleic acid molecules of the clones and the nucleic acid molecule; (c)selecting clones which hybridized with the nucleic acid molecule; and (d) isolating the clones which carry the hybridized inserts, thereby identifying the inserts encoding the odorant receptors.

This invention also provides a method to identify DNA inserts encoding an insect odorant receptors comprising:
(a) generating DNA libraries which contain clones with inserts from a sample which contains at least one antenna or maxillary palp sensory neuron; (b) contacting the clones from the DNA libraries generated in step (a) with appropriate polymerase chain reaction primers capable of specifically binding to nucleic acid molecules encoding odorant receptors in appropriate conditions permitting the amplification of the

hybridized inserts by polymerase chain reaction; (c) selecting the amplified inserts; and (d) isolating the amplified inserts, thereby identifying the inserts encoding the odorant receptors.

This invention also provides a method to isolate DNA molecules encoding insect odorant receptors comprising: (a) contacting a biological sample known to contain nucleic acids with appropriate polymerase chain reaction primers capable of specifically binding to nucleic acid molecules encoding insect odorant receptors in appropriate conditions permitting the amplification of the hybridized molecules by polymerase chain reaction; (b) isolating the amplified molecules, thereby identifying the DNA molecules encoding the insect odorant receptors.

This invention also provides a method of transforming cells which comprises transfecting a host cell with a suitable vector described above.

This invention also provides transformed cells produced by the above method. In an embodiment, the host cells are not usually expressing odorant receptors. In another embodiment, the host cells are expressing odorant receptors.

This invention provides a method of identifying a compound capable of specifically binding to an insect odorant receptor which comprises contacting a transfected cells or membrane fractions of the above described transfected cells with an appropriate amount of the compound under conditions permitting binding of the compound to such receptor, detecting the presence of any such compound specifically bound to the receptor, and thereby determining whether the compound specifically binds to the receptor.

This invention provides a method of identifying a compound capable of specifically bind to an insect odorant receptor which comprises contacting an appropriate amount of the

purified insect odorant receptor with an appropriate amount of the compound under conditions permitting binding of the compound to such purified receptor, detecting the presence of any such compound specifically bound to the receptor, and thereby determining whether the compound specifically binds to the receptor. In an embodiment, the purified receptor is embedded in a lipid bilayer.The purified receptor may be embedded in the liposomes with proper orientation to carry out normal functions. Liposome technology is well-known in the art.

This invention also provides a method of identifying a compound capable of activating the activity of an insect odorant receptor which comprises contacting the transfected cells or membrane fractions of the above-described transfected cells with the compound under conditions permitting the activation of a functional odorant receptor response, the activation of the receptor indicating that the compound is capable of activating the activity of a odorant receptor.

This invention also provides a method of identifying a compound capable of activating the activity of an odorant receptor which comprises contacting a purified insect odorant receptor with the compound under conditions permitting the activation of a functional odorant receptor response, the activation of the receptor indicating that the compound is capable of activating the activity of a odorant receptor. In an embodiment, the purified receptor is embedded in a lipid bilayer.

This invention also provides a method of identifying a compound capable of inhibiting the activity of a odorant receptor which comprises contacting the transfected cells or membrane fractions of the above-described transfected cells with an appropriate amount of the compound under conditions permitting the inhibition of a functional odorant receptor response, the inhibition of the receptor response indicating

that the compound is capable of inhibiting the activity of a odorant receptor.

This invention provides a method of identifying a compound capable of inhibiting the activity of a odorant receptor which comprises contacting an appropriate amount of the purified insect odorant receptor with an appropriated amount of the compound under conditions permitting the inhibition of a functional odorant receptor response, the inhibition of the receptor response indicating that the compound is capable of activating the activity of a odorant receptor. In an embodiment, the purified receptor is embedded in a lipid bilayer.

In a separate embodiment of the above method, the compound is not previously known. This invention also provides the compound identified by the above-described methods.

This invention provides a method of controlling pest populations which comprises identifying odorant ligands by the above-described method which are alarm odorant ligands and spraying the desired area with the identified odorant ligands.

Finally, this invention provides a method of controlling a pest population which comprises identifying odorant ligands by the above-described method which interfere with the interaction between the odorant ligands and the odorant receptors which are associated with fertility.

This invention will be better understood from the Experimental Procedures which follow. However, one skilled in the art will readily appreciate that the specific methods and results discussed are merely illustrative of the invention as described more fully in the claims which follow thereafter.

EXPERIMENTAL PROCEDURES

Experimental Animals

Oregon R flies (Drosophila melanogaster) were raised on standard cornmeal-agar-molasses medium at 25°C. Transgenic constructs were injected into *yw* embryos. C155 *elav*-GAL4 flies were obtained from Corey Goodman (Lin and Goodman, 1994) and Gary Struhl provided the UAS- (cytoplasmic) lacZ stock.

Preparation and differential screening of a Drosophila antennal/maxillary palp cDNA library

Drosophila antennae and maxillary palps were obtained by manually decapitating and freezing 5000 adult flies and shaking antennae and maxillary palps through a fine metal sieve. mRNA was prepared using a polyA+ RNA Purification Kit (Stratagene). An antennal/maxillary palp cDNA library was made from 0.5 μg mRNA using the LambdaZAPIIXR kit from Stratagene.

Briefly, phage were plated at low density (500-1000 pfu/150mm plate) and UV-crosslinked after lifting in triplicate to Hybond-N+ (Amersham). Complex probes were generated by random primed labeling (PrimeItII, Stratagene) of reverse transcribed mRNA (RT-PCR kit, Stratagene) from virgin adult female body mRNA and duplicate lifts hybridized at high stringency for 36 hours (65°C in 0.5M Sodium Phosphate buffer [pH7.3] containing 1% bovine serum albumin, 4% SDS, and 0.5 mg/ml herring sperm DNA). We prescreened the third lift with a mix of all previously cloned OBPs/PBPs (McKenna et al., 1994; Pikielny et al., 1994; Kim et al., 1998) remove a source of abundant but undesired olfactory-specific clones. Approximately 5000 individual OBP/PBP and virgin female body negative phage clones were isolated, their inserts amplified by PCR with T3 and T7 primers, and approximately 3 μg of DNA were electrophoresed on 1.5% agarose gels. Gels were blotted in duplicate to Hybond-N+ (Amersham), filters were

UV-crosslinked, and the resulting Southern blots were subjected to reverse Northern analysis using complex probes generated from virgin female body mRNA. Approximately 500 clones not hybridizing with virgin female body probes were identified and consolidated onto secondary Southern blots in triplicate. These blots were probed with complex probes derived from antennal/maxillary palp, head-minus-antenna/maxillary palp, and virgin female body mRNA. A total of 210 clones negative with head-minus-antenna/maxillary palp and virgin female body probes and strongly positive, weakly positive, or negative with antennal/maxillary palp probes were further analyzed by sequencing and *in situ* hybridization.

Analysis of Drosophila Genome Project Sequences for Transmembrane Proteins

All Drosophila genomic sequences were batch downloaded in April 1998 from the Berkeley Drosophila Genome Project (Berkeley Drosophila Genome Project, unpublished). Genomic P1 sequences were first analyzed with the GENSCAN program (Burge and Karlin, 1997; http://CCR-081.mit.edu/GENSCAN.html), which predicts intron-exon structures and generates hypothetical coding sequences (CDS) and open reading frames. GENSCAN predicted proteins shorter than 50 amino acids were discarded. The remaining open reading frames were used to search for putative transmembrane regions greater than 15 amino acids with two programs that were obtained from the authors and used in stand-alone mode locally (see Persson and Argos, 1994; Cserzo et al., 1997). The Dense Surface Alignment (DAS) program is available at http://www.biokemi.su.se/~server/DAS/ or from M. Cserzo (miklos@pugh.bip.bham.ac.uk). TMAP is available at ftp://ftp.ebi.ac.uk/pub/software/unix/, or by contacting the author, Bengt Persson (bpn@mbb.ki.se). Scripts were written to apply the DAS and TMAP programs repeatedly to genome scale sequence sets. Genes showing significant sequence similarity to the NCBI non-redundant protein

database using BLAST analysis (Altschul et al., 1990; Altschul et al., 1997) were eliminated. All scripts required for these computations were written in standard ANSI C and run on a SUN Enterprise 3000.

Of 229 novel Drosophila proteins with three or more predicted transmembrane spanning regions, 35 showed no clear sequence similarity to any known protein and were selected for further analysis by *in situ* hybridization. Probes for *in situ* hybridization were generated by RT-PCR using antennal/maxillary palp mRNA as a template.

Map positions of DOR Genes

The chromosome position of DOR104 was determined by *in situ* hybridization of a biotin-labeled probe to salivary gland polytene chromosome squashes as described (Amrein et al., 1988).

Chromosomal positions of all other DOR genes were based on chromosome assignments of the P1 clones to which they map, as determined by the Berkeley Drosophila Genome Project (personal communication; http://www.fruitfly.org; see also Hartl et al., 1994; Kimmerly et al., 1996). DOR62 maps to a cosmid sequenced by the European Drosophila Genome Project (unpublished; http://edgp.ebi.ac.uk/; Siden-Kiamos et al., 1990).

RECEPTOR	MAP POSITION	P1 CLONE ACCESSION NUMBER
DOR62	(X) 2F	62D9 (EDGP cosmid)
DOR67	(2L) 22A3	DS00676
DOR53	(2L) 22A2-3	DS05342
DOR64	(2L) 23A1-2	DS06400
DOR71	(2L) 33B1-2	DS07071
DOR72	(2L) 33B1-2	DS07071
DOR73	(2L) 33B1-2	DS07071
DOR87	(2R) 43B1-2	DS08779
DOR19	(2R) 46F5-6	DS01913
DOR24	(2R) 47D6-E2	DS00724
DOR46	(2R) 59D5-7	DS07462
DOR104	(3L) 85B	not applicable

The Isolation of DOR cDNA Clones and Southern Blotting

We screened $3x10^6$ clones of the antennal/maxillary palp library described above with PCR probes for the genes DOR87, DOR53, DOR67, DOR64, and DOR62. cDNAs were present at a frequency ranging from 1:200,000 (DOR67) to 1:1,000,000 (DOR62) in the library and their sequences were remarkably similar to the hypothetical CDS predicted by the GENSCAN program. The frequency of these genes is similar to that of DOR104, which is present at 1:125,000 in the antennal/maxillary palp library. All sequencing was with ABI cycle sequencing kits and reactions were run on an ABI 310 or 377 sequencing system.

Five μg of Oregon R genomic DNA isolated from whole flies were digested with BamHI, EcoRI, or HindIII, electrophoresed on 0.8% agarose gels, and blotted to Nitropure nitrocellulose membranes (Micron Separations Inc.). Blots were baked and annealed with ^{32}P-labeled probes derived from cDNA probes of DOR53 and DOR67, or PCR fragments from DOR24, DOR62, and DOR72. Hybridization was at 42°C for 36 hours in 5XSSCP, 10X Denhardts, 500 μg/ml herring sperm DNA, and either 50% (high stringency) or 25% (low stringency) formamide (Sambrook et al., 1989). Blots were washed for 1 hour in 0.2X SSC, 0.5% SDS at 65°C (high stringency) or 1XSSC, 0.5% SDS at 42°C (low stringency).

***In situ* Hybridization**

RNA *in situ* hybridization was carried out essentially as described (Schaeren-Wiemers and Gerfin-Moser, 1993). This protocol was modified to include detergents in most steps to increase sensitivity and reduce background. The hybridization buffer contained 50% formamide, 5X SSC, 5X Denhardts, 250 μg/ml yeast tRNA, 500 μg/ml herring sperm DNA, 50 μg/ml Heparin, 2.5 mM EDTA, 0.1% Tween-20, 0.25% CHAPS. All antibody steps were in the presence of 0.1% Triton X-100, and the reaction was developed in buffer containing 0.1%

Tween-20. Slides were mounted in Glycergel (DAKO) and viewed with Nomarski optics.

Fluorescent *in situ* hybridization was carried out as above with either digoxigenin or FITC labeled RNA probes. The digoxigenin probe was visualized with sheep anti-digoxigenin (Boehringer) followed by donkey anti-sheep CY3 (Jackson). FITC probes were visualized with mouse anti-FITC (Boehringer) and goat anti-mouse Alexa 488 (Molecular Probes) following preincubation with normal goat serum. Sections were mounted in Vectashield reagent (Vector Labs) and viewed on a Biorad 1024 Confocal Microscope.

For double labeling with a neural marker, animals of the genotype C155 *elav*-Gal4; UAS-lacZ were sectioned and first hybridized with a digoxigenin labeled antisense DOR104 RNA probe and developed as described above. Neuron-specific expression of lacZ driven by the *elav*-Gal4 enhancer trap was visualized with a polyclonal rabbit anti-ß-galactosidase antibody (Organon-Technika/Cappel), visualized by a goat anti-rabbit Alexa488 conjugated secondary antibody (Molecular Probes) following preincubation with normal goat serum.

The proportion of neurons in the third antennal segment was calculated by comparing the number of nuclei staining with the 44C11 ELAV monoclonal (kindly provided by Lily Jan) and those staining with TOTO-3 (Molecular Probes), a nucleic acid counterstain, in several confocal sections of multiple antennae. On average, 36% of the nuclei in the antenna were ELAV positive.

DOR104-lacZ Transgene Construction and Histochemical Staining

A genomic clone containing the DOR104 coding region and several kb of upstream sequence was isolated from a genomic library prepared from flies isogenic for the third chromosome (a gift of Kevin Moses and Gerry Rubin). Approximately 3 kb of DNA immediately upstream of the putative translation start

site of DOR104 were isolated by PCR and subcloned into the pCasperAUGßGal vector (Thummel et al., 1988). ß-galactosidase activity staining was carried out with whole mount head preparations essentially as described in Wang et al. (1998). Frozen sections of DOR104-lacZ maxillary palps were incubated with a polyclonal rabbit anti-ß-galactosidase antibody and as described above.

EXPERIMENTAL RESULTS

Cloning Candidate Odorant Receptors

In initial experiments, we isolated a cDNA encoding a putative odorant receptor by a difference cloning strategy designed to detect cDNA copies of mRNA present at extremely low frequencies in an mRNA population. In the antenna and maxillary palp, about 30% of the cells are olfactory neurons. If each neuron expressed only one of a possible 100 different odorant receptor genes at a level of 0.1% of the mRNA in a sensory neuron, then a given receptor mRNA would be encountered at a frequency of one in 300,000 in antennal mRNA. If 100 different receptor genes were expressed, then the entire family of receptor genes would be represented at a frequency of one in 3,000 mRNAs. We therefore introduced experimental modifications into standard difference cloning to allow for the identification of extremely rare mRNAs whose expression is restricted to either the antenna or the maxillary palp.

Briefly, 5000 insets from an antennal/maxillary palp cDNA library were prescreened (see Experimental Procedures) and then subjected to Southern blot hybridization with cDNA probes from antennal/maxillary palp, head minus antenna/maxillary palp, or virgin female body mRNA (see Figure 1). This Southern blot hybridization (or reverse Northern) to candidate cDNAs allows for the detection of sequences present at a frequency of 1 in 100,000 in the probe, a sensitivity about one hundred-fold greater than that of plaque screening (see Experimental Procedures). This procedure led to the identification of multiple antennal/maxillary palp-specific cDNAs that were analyzed by DNA sequencing and *in situ* hybridization. One cDNA, DOR104 (for Drosophila Odorant Receptor) (Figure 1, Lane 9), encodes a putative seven-transmembrane domain protein with no obvious sequence similarity to known serpentine receptors (Figure 3). *In situ* hybridization revealed that this cDNA anneals to

about 15% of the 120 sensory neurons within the maxillary palp but does not anneal with neurons in either the brain or antenna. Seven cells expressing DOR104 are shown in the frontal maxillary palp section in Figure 2A.

These observations suggested that DOR104 might be one member of a larger family of odorant receptor genes within the Drosophila genome. However, we were unable to identify additional genes homologous to DOR104 by low stringency hybridization to genomic DNA and cDNA libraries or upon analysis of linked genes in a genomic walk. We therefore analyzed the Drosophila genome database for families of multiple transmembrane domain proteins that share sequence similarity with DOR104. Sequences representing about 10% of the Drosophila genome were downloaded (Berkeley Drosophila Genome Project) and subjected to GENSCAN analysis (Burge and Karlin, 1997) to predict the intron-exon structure of all sequences within the database. Open reading frames greater than 50 amino acids were searched for proteins with three or more predicted transmembrane-spanning regions using the dense alignment surface (DAS) and TMAP algorithms (Persson and Argos, 1994; Cserzo et al., 1997; also see Experimental Procedures). Of 229 candidate genes identified in this manner, 11 encoded proteins that define a novel divergent family of presumed seven transmembrane domain proteins with sequence similarity to the DOR104 sequence. This family of candidate odorant receptors does not share any conserved sequence motifs with previously identified families of seven transmembrane domain receptors. cDNA clones containing the coding regions for 5 of the 11 genes identified by GENSCAN analysis have been isolated from an antennal/maxillary palp cDNA library and their sequences are provided in Figure 3. The remaining 6 protein sequences derive from GENSCAN predictions for intron-exon arrangement. Their organization conforms well to the actual structure determined from the cDNA sequences of other members of the gene family (Figure 3).

The receptors consist of a short extracellular N-terminal domain (usually less than 50 amino acids) and seven presumed membrane-spanning domains. Analysis of presumed transmembrane domains (Kyte and Doolittle, 1982; Persson and Argos, 1994; Cserzo et al., 1997) reveals multiple hydrophobic segments, but it is not possible from this analysis to unequivocally determine either the number or placement of the membrane spanning domains. At present, our assignment of transmembrane domains is therefore tentative.

The individual family members are divergent and most exhibit from 17-26% amino acid identity. Two linked clusters of receptor genes constitute small subfamilies of genes with significantly greater sequence conservation. Two linked genes, DOR53 and DOR67, exhibit 76% amino acid identity, whereas the three linked genes, DOR71, 72 and 73, reveal 30-55% identity (Figure 3; see below). Despite the divergence, each of the genes shares short, common motifs in fixed positions within the putative seven transmembrane domain structure that define these sequences as highly divergent members of a novel family of putative receptor molecules.

<u>Expression of the DOR Gene Family in Olfactory Neurons</u>

If this gene family encodes putative odorant receptors in the fly, we might expect that other members of the family in addition to DOR104 would also be expressed in olfactory sensory neurons. We therefore performed *in situ* hybridization to examine the pattern of receptor expression of each of the 11 additional members of the gene family in adult and developing organisms. In Drosophila, olfactory sensory neurons are restricted to the maxillary palp and third antennal segment. The third antennal segment is covered with approximately 500 fine sensory bristles or sensilla (Stocker, 1994), each containing from one to four neurons (Venkatesh and Singh, 1984). The maxillary palp is covered with approximately 60 sensilla, each of which is innervated by two

or three neurons (Singh and Nayak, 1985). Thus, the third antennal segment and maxillary palp contain about 1500 and 120 sensory neurons, respectively.

RNA *in situ* hybridization experiments were performed with digoxigenin-labeled RNA antisense probes to each of the 11 new members of the gene family under conditions of high stringency. One linked pair of homologous genes, DOR53 and DOR67, crosshybridizes, whereas the remaining 10 genes exhibit no crosshybridization under these conditions (see below). Eight of the 11 genes hybridize to a small subpopulation (0.5-1.5%) of the 1500 olfactory sensory neurons in the third antennal segment (Figure 4). One gene, DOR71, is expressed in about 10% of the sensory neurons in the maxillary palp but not in the antenna (Figure 4G). We have not detected expression of DOR46 or DOR19 in the antenna or the maxillary palp. Expression of this gene family is only observed in cells within the antenna and maxillary palp. No hybridization was observed in neurons of the brain, nor was hybridization observed in any sections elsewhere in the adult fly or in any tissue at any stage during embryonic development. However, we do find hybridization to a small number of cells in the developing antennae in the late pupal stage (data not shown). We have not yet determined whether this family of receptors is expressed in the larval olfactory apparatus.

Only about one third of the cells in the third antennal segment and the maxillary palp are neurons (data not shown), which are interspersed with non-neuronal sensillar support cells and glia. We have performed two experiments to demonstrate that the family of seven transmembrane domain receptor genes is expressed in sensory neurons rather than support cells or glia within the antenna and maxillary palp. First, we developed two-color fluorescent antibody detection schemes to co-localize receptor expression in cells that express the neuron-specific RNA binding protein, ELAV (Robinow and White, 1988). An enhancer trap line carrying an insertion of GAL4 at the *elav* locus expresses high levels of

lacZ in neurons when crossed to a transgenic UAS-lacZ responder line (Lin and Goodman, 1994). Fluorescent antibody detection of lacZ identifies the sensory neurons in a horizontal section of the maxillary palp (Figure 5B). Hybridization with the receptor probe DOR104 reveals expression in 5 of the 12 lacZ positive cells in a horizontal section of the maxillary palp (Figure 5A). All cells that express DOR104 are also positive for lacZ (Figure 5C), indicating that this receptor is expressed only in neurons.

In a second experiment we have demonstrated that the receptor genes are not expressed in non-neuronal cells. The support cells of the antenna express different members of a family of odorant binding proteins (McKenna et al., 1994; Pikielny et al., 1994; Kim et al., 1998). These genes encode abundant low molecular weight proteins thought to transport odorants through the sensillar lymph (reviewed in Pelosi, 1994). Two-color *in situ* experiments with a probe for the odorant binding protein, PBPRP2 (Pikielny et al., 1994), reveal hybridization to a large number of cells broadly distributed throughout the antenna (Figure 5F). In the same section, however, the probe DOR53 anneals to a non-overlapping subpopulation of neurons restricted to the medial-proximal domain of the antenna. In a similar experiment, *in situ* hybridization with the odorant binding protein, OS-F (McKenna et al., 1994), identifies a spatially restricted subpopulation of support cells in the antenna, whereas the DOR67 probe identifies a distinct subpopulation of neurons in a medial-proximal domain (Figure 5G). Thus, the putative odorant receptor genes are expressed in a subpopulation of sensory neurons distinct from the support cells that express the odorant binding proteins. Taken together, these data demonstrate that 10 of the 12 family members we have identified are expressed in small subpopulations of olfactory sensory neurons in the antenna and maxillary palp.

Spatially Defined Patterns of Receptor Expression

The *in situ* hybridization experiments reveal that each receptor is expressed in a spatially restricted subpopulation of neurons in the antenna or maxillary palp (Figure 4). The total number of cells expressing each receptor per antenna was obtained by counting the positive cells in serial sections of antennae from multiple flies. These numbers are presented in the legend of Figure 4. DOR67 and 53, for example, anneal to about 20 neurons on the medial proximal edge of the antenna (Figure 4A and B), whereas DOR62 and 87 anneal to subpopulations of 20 cells at the distal edge of the antenna (Figure 4C-D). Approximately 10 cells in the distal domain express DOR64 (Figure 4E). Each of the three linked genes DOR71, 72, and 73 is expressed in different neurons. DOR72 is expressed in approximately 15 antennal cells (Figure 4H), while DOR73 is expressed in 1 to 2 cells at the distal edge of the antenna (Figure 4I). In contrast, DOR71 is expressed in approximately 10 maxillary palp neurons but is not detected in the antenna (Figure 4G). The three sensillar types are represented in a coarse topographic map across the third antennal segment. The proximal-medial region, for example, contains largely basiconic sensilla. Receptors expressed in this region (DOR53 and 67) are therefore likely to be restricted to the large basiconic sensilla. More distal regions contain a mixture of all three sensilla types and it is therefore not possible from these data to assign specific receptors to specific sensillar types.

The spatial pattern of neurons expressing a given receptor is conserved between individuals. *In situ* hybridization with two receptor probes to three individual flies reveals that both the frequency and spatial distributions of the hybridizing neurons is conserved in different individuals (Figure 6). At present, we cannot determine the precision of this topographic map and can only argue that given receptors are expressed in localized domains.

In preliminary experiments, we have demonstrated that the spatial pattern of expression of one receptor, DOR104, can be recapitulated in transgenic flies with a promoter fragment flanking the DOR104 gene. The fusion of the presumed DOR104 promoter (consisting of 3 kb of 5' DNA immediately adjacent to the coding region) to the lacZ reporter gene has allowed us to visualize a subpopulation of neurons expressing DOR104 within the maxillary palp. Whole mount preparations of the heads of transgenic flies reveal a small subpopulation of sensory neurons within the maxillary palp whose cell bodies exhibit blue color after staining with X-gal (Figure 2B). The number of positive cells, approximately 20 per maxillary palp, corresponds well with that seen for DOR104 RNA expression. Immunofluorescent staining of sections with antibodies directed against ß-galactosidase more clearly reveals the dendrites and axons of these bipolar neurons in the maxillary palp (Figure 2C). Levels of lacZ expression in these transgenic lines are low and further amplification will be necessary to allow us to trace the axons to glomeruli in the antennal lobe. Nonetheless, the data suggest that the information governing the spatial pattern of DOR104 expression in a restricted subpopulation of maxillary palp neurons resides within 3 kb of DNA 5' to the DOR104 gene.

<u>Individual Neurons Express Different Complements of Receptors</u>

An understanding of the logic of olfactory discrimination in Drosophila will require a determination of the diversity and specificity of receptor expression in individual neurons. In the vertebrate olfactory epithelium, a given neuron is likely to express only one receptor from the family of 1,000 genes (Ngai et al., 1993; Ressler et al., 1993; Vassar et al., 1993; Chess et al., 1994; Dulac and Axel, unpublished). In the nematode C. elegans, however, individual chemosensory neurons are thought to express multiple receptor genes (Troemel et al., 1995). Our observations with the putative Drosophila odorant receptors indicate that a given receptor probe anneals with 0.5-1.5% of antennal neurons, suggesting that each cell expresses only a subset of receptor genes. If

we demonstrate that each of the different receptor probes hybridizes with distinct, nonoverlapping subpopulations of neurons, this would provide evidence that neurons differ with respect to the receptors they express.

In situ hybridization was therefore performed with either a mix of five receptor probes (Figure 4F) or individually with each of the five probes (Figure 4A-E). We observe that the number of olfactory neurons identified with the mixed probe (about 60 per antenna) approximates the sum of the positive neurons detected with the five individual probes. These results demonstrate that individual receptors are expressed in distinct nonoverlapping populations of olfactory neurons.

We have performed an additional experiment using two-color RNA *in situ* hybridization to ask whether two receptor genes, DOR64 and DOR87, expressed in interspersed cells in the distal antenna are expressed in different neurons. Antisense RNA probes for the two genes were labeled with either digoxigenin- or FITC-UTP and were used in pairwise combinations in *in situ* hybridization to sections through the Drosophila antenna. Although these two genes are expressed in overlapping lateral-distal domains, two-color *in situ* hybridization reveals that neurons expressing DOR64 do not express DOR87, rather each gene is expressed in distinct cell populations (Figure 5D and E). Taken together, these data suggest that olfactory sensory neurons within the antenna are functionally distinct and express different complements of odorant receptors. At the extreme, the experiments are consistent with a model in which individual neurons express only a single receptor gene.

Our differential cloning procedure identified one additional gene, A45, which shares weak identity (24%) with the DOR gene family over a short region (93 amino acids). This gene, however, does not appear to be a classical member of the DOR family: it is far more divergent and significantly larger

than the other family members (486 amino acids). This gene is expressed in all olfactory sensory neurons (data not shown). If A45 does encode a divergent odorant receptor, then it would be present in all sensory neurons along with different complements of the more classical members of the DOR gene family.

The Size and Organization of the Odorant Receptor Gene Family

How large is the family of odorant receptor genes in Drosophila? Unlike vertebrate odorant receptors, which share 40-98% sequence identity at the amino acid level, the fly receptors are extremely divergent. The extent of sequence similarity between receptor subfamilies ranges from 20-30%. The maxillary palp receptor DOR104 is the most distantly related member of the family with about 17% identity to the other receptor genes. Inspection of the receptor sequences suggests that Southern blot hybridizations, even those performed at low stringency, are unlikely to reveal multiple additional members of a gene family. In accord with this, Southern blot hybridization with receptor probes DOR24, 62, and 72, performed at either high or low stringency, reveals only a single hybridizing band following cleavage of genomic DNA with three different restriction endonucleases (Figure 7C-E). The two linked clusters of receptors contain genes with a greater degree of sequence conservation and define small subfamilies of receptor genes. A cluster of three receptors, DOR71, 72, and 73, is located at map position 33B1-2. The antennal receptors DOR72 and 73 are 55% identical and both exhibit about 30% identity to the third gene at the locus, DOR71, which is expressed in the maxillary palp. DOR67 and DOR53, members of a second subfamily, reside within 1 kb of each other at map position 22A2-3 and exhibit 76% sequence identity. Not surprisingly, these two linked genes crosshybridize at low stringency. Southern blots probed with either DOR67 or DOR53 reveal two hybridizing bands corresponding to the two genes within the subfamily but fail to detect additional subfamily members in the chromosome (Figure 7A and B).

The members of the receptor gene family described here are present on all but the small fourth chromosome. No bias is observed toward telomeric or centromeric regions. The map positions, as determined from P1 and cosmid clones (Berkeley Drosophila Genome Project; European Drosophila Genome Project) are provided in Experimental Procedures. A comparatively large number of receptor genes map to chromosome 2 because the Berkeley Drosophila Genome Project has concentrated its efforts on this chromosome. Unlike the distribution of odorant receptors in nematodes and mammals (Ben-Arie et al., 1994; Troemel et al., 1995; Robertson, 1998), only small linked arrays have been identified and the majority of the family members are isolated at multiple, scattered loci in the Drosophila genome.

The high degree of divergence among members of the Drosophila odorant receptor gene family is more reminiscent of the family of chemoreceptors in C. elegans than the more highly conserved odorant receptors of vertebrates. Estimates of the size of the Drosophila receptor gene family, therefore, cannot be obtained by either Southern blot hybridization or PCR analysis of genomic DNA. Rather, our estimates of the gene family derive from the statistics of small numbers. We detect 12 members of the odorant receptor gene family from a Drosophila genome database that includes roughly 10% of the genome. Recognizing a possible bias in our estimate, it seems reasonable at present to estimate that the odorant receptor family is likely to include 100 to 200 genes. This is in accord with independent estimates from *in situ* hybridization experiments that demonstrate that a given receptor probe hybridizes with 0.5-1.5% of the neurons. If we assume that a given neuron expresses only a single receptor gene, these observations suggest that the gene family would include 100 to 200 members.

EXPERIMENTAL DISCUSSION

The Size and Divergence of the Gene Family

We have identified a novel family of seven transmembrane domain proteins that is likely to encode the Drosophila odorant receptors. The number of different receptor genes expressed in the neurons of the antenna and maxillary palp will reflect the diversity and specificity of odor recognition in the fruit fly. How large is the Drosophila odorant receptor gene family? We have identified 11 members of this divergent gene family in the Drosophila DNA database. The potential for bias notwithstanding, it seems reasonable to assume then that since only 10% of genomic sequence has been deposited, this gene family is likely to contain from 100 to 200 genes. However, significant errors in our estimates could result from bias in the nature of the sequences represented in the 10% of the Drosophila genome analyzed to date. *In situ* hybridization experiments demonstrating that each of the receptor genes labels from 0.5-1.5% of the olfactory sensory neurons are in accord with the estimate of 100 to 200 receptor genes.

Several divergent odorant receptor gene families, each encoding seven transmembrane proteins, have been identified in vertebrate and invertebrate species. In mammals, volatile odorants are detected by a family of as many as 1,000 receptors each expressed in the main olfactory epithelium (Buck and Axel, 1991; Levy et al., 1991; Parmentier et al., 1992; Ben-Arie et al., 1994). This gene family shares features with the serpentine neurotransmitter receptors and is conserved in all vertebrates examined. Terrestrial vertebrates have a second anatomically and functionally distinct olfactory system, the vomeronasal organ, dedicated to the detection of pheromones. Vomeronasal sensory neurons express two distinct families of receptors each thought to contain from 100 to 200 genes: one novel family of serpentine receptors (Dulac and Axel, 1995), and a second related to the

metabotropic neurotransmitter receptors (Herrada and Dulac, 1997; Matsunami and Buck, 1997; Ryba and Tirindelli, 1997).

In the invertebrate C. elegans, chemosensory receptors are organized into four gene families that share 20-40% sequence similarity within a family and essentially no sequence similarity between families (Troemel et al., 1995; Sengupta et al., 1996; Robertson, 1998). The four gene families in C. elegans together contain about 1,000 genes engaged in the detection of odors. The nematode receptors exhibit no sequence conservation with the three distinct families of vertebrate odorant receptor genes. Our studies reveal that Drosophila has evolved an additional divergent gene family of serpentine receptors comprised of from 100 to 200 genes. The observation that a similar function, chemosensory detection, is accomplished by at least eight highly divergent gene families, sharing little or no sequence similarity, is quite unusual.

Why is the evolutionary requirement for odorant receptors so often met by recruitment of novel gene families rather than exploiting pre-existing odorant receptor families in ancestral genomes? The character of natural odorants along with their physical properties (e.g. aqueous or volatile) represent important selectors governing the evolution of receptor gene families. The use of common "anthropomorphic" odorant sets in the experimental analysis of olfactory specificity has led to the prevailing view that significant overlap exists in the repertoire of perceived odors between different species. Studies of odorant specificity in different species often employ odors at artificially high concentrations and may present an inaccurate image of the natural repertoire of odorants. We simply do not know the nature of the odors that initially led to the ancestral choice of receptor genes during the evolution of the nematode, insect, or vertebrate species. Clearly, vastly different properties in salient odors could dictate the recruitment of new gene families to effect an old function,

olfaction. The character of the odor is not the only evolutionary selector. Odorant receptors must interact with other components in the signal transduction pathway [G proteins (for review see Buck, 1996; Bargmann and Kaplan, 1998) and perhaps even RAMPs (McLatchie et al, 1998) and rho (Mitchell et al., 1998)] that may govern the choice of one family of serpentine receptors over another. Moreover, mammalian receptors not only recognize odorants in the environment but are likely to recognize guidance cues governing formation of a sensory map in the brain (Wang et al., 1998). Thus, the multiple properties required of the odorant receptors might change vastly over evolutionary time and this might underlie the independent origins of the multiple chemosensory receptor gene families.

Establishing a Topographic Map in the Antenna and the Brain

We observe that individual receptor genes in the fly are expressed in topographically conserved domains within the antenna. This highly ordered spatial distribution of receptor expression differs from that observed in the mammalian olfactory epithelium. In mammals, a given receptor can be expressed in one of four broad but circumscribed zones in the main olfactory epithelium (Ressler et al., 1993; Vassar et al., 1993). A given zone can express up to 250 different receptors and neurons expressing a given receptor within a zone appear to be randomly dispersed (Ressler et al., 1993; Vassar et al., 1993). The highly ordered pattern of expression observed in the Drosophila antenna might have important implications for patterning the projections to the antennal lobe. In visual, somatosensory, and auditory systems the peripheral receptor sheet is highly ordered and neighbor relations in the periphery are maintained in the projections to the brain. These observations suggest that the relative position of the sensory neuron in the periphery will determine the pattern of projections to the brain.

Our data on the spatial conservation of receptor expression in the antenna suggest that superimposed upon coarse spatial

patterning of olfactory sensilla (Venkatesh and Singh, 1984; Ray and Rodrigues, 1995; Reddy et al., 1997) must be more precise positional information governing the choice of receptor expression. This spatial information might dictate the fixed topographic pattern of receptor expression in the peripheral receptor sheet and at the same time govern the ordered sensory projections to the brain. This relationship between positional identity and the pattern of neuronal projections has been suggested for both peripheral sensory neurons (Merritt and Whitington, 1995; Grillenzoni et al., 1998) and neurons in the embryonic central nervous system of Drosophila (Doe and Skeath, 1996).

Implications for Sensory Processing

In mammals, olfactory neurons express only one of the thousand odorant receptor genes. Neurons expressing a given receptor project with precision to 2 of the 1800 glomeruli in the mouse olfactory bulb. Odorants will therefore elicit spatially defined patterns of glomerular activity such that the quality of an olfactory stimulus is encoded by the activation of a specific combination of glomeruli (Stewart et al., 1979; Lancet et al., 1982; Kauer et al., 1987; Imamura et al., 1992; Mori et al., 1992; Katoh et al., 1993; Friedrich and Korsching, 1997). Moreover, the ability of an odorant to activate a combination of glomeruli allows for the discrimination of a diverse array of odors far exceeding the number of receptors and their associated glomeruli. In the nematode, an equally large family of receptor genes is expressed in 16 pairs of chemosensory cells, only three of which respond to volatile odorants (Bargmann and Horvitz, 1991; Bargmann et al., 1993). This immediately implies that a given chemosensory neuron will express multiple receptors and that the diversity of odors recognized by the nematode might approach that of mammals, but the discriminatory power is necessarily dramatically reduced.

What does the character of the gene family we have identified in Drosophila tell us about the logic of olfactory processing

in this organism? We estimate that the Drosophila odorant receptors comprise a family of from 100 to 200 genes. Moreover, the pattern of expression of these genes in the third antennal segment suggests that individual sensory neurons express a different complement of receptors and, at the extreme, our data are consistent with the suggestion that individual neurons express one or a small number of receptors. As in the case of mammals, the problem of odor discrimination therefore reduces to a problem of the brain discerning which receptors have been activated by a given odorant. If the number of different types of neurons exceeds the number of glomeruli (43) (Stocker, 1994; Laissue et al., 1999), it immediately follows that a given glomerulus must receive input from more than one kind of sensory neuron. This implies that a single glomerulus will integrate multiple olfactory stimuli. One possible consequence of this model would be a loss of discriminatory power while maintaining the ability to recognize a vast array of odors. Alternatively, significant processing of sensory input may occur in the fly antennal lobe to afford discrimination commensurate with the large number of receptors.

This model of olfactory coding is in sharp contrast with the main olfactory system of vertebrates in which sensory neurons express only a single receptor and converge on only a single pair of spatially fixed glomeruli in the olfactory bulb. Moreover, each projection neuron in the mammalian bulb extends its dendrite to only a single glomerulus. Thus the integration and decoding of spatial patterns of glomerular activity, in vertebrates, must occur largely in the olfactory cortex. In the fruit fly, the observation that the number of receptors may exceed the number of glomeruli suggests that individual glomeruli will receive input from more than one type of sensory neuron. A second level of integration in the antennal lobe is afforded by subsets of projection neurons that elaborate extensive dendritic arbors that synapse with multiple glomeruli. Thus, the Drosophila olfactory system reveals levels of processing and integration of sensory input

in the antennal lobe that is likely to be restricted to higher cortical centers in the main olfactory system of vertebrates.

Protein and Nucleic Acid (nt) Sequences of 55 Drosophila Odorant Receptor Genes

The following includes those genes first identified in 1998-1999. Protein sequences used single letter amino acid codes.

DOR10

MEKLRSYEDFIFMANMMFKTLGYDLFHTPKPWWRYLLVRGYFVLCTISNFYEASMVTT
RIIEWESLAGSPSKIMRQGLHFFYMLSSQLKFITFMINRKRLLQLSHRLKELYPHKEQ
NQRKYEVNKYYLSCSTRNVLYVYYFVMVVMALEPLVQSQFIVNVSLGTDLWMMCVSSQ
ISMHLGYLANMLASIRPSPETEQQDCDFLASIIKRHQLMIRLQKDVNYVFGLLLASNL
FTTSCLLCCMAYYTVVEGFNWEGISYMMLFASVAAQFYVVSSHGQMLIDLLMTITYRF
FAVIRQTVEK

DOR10nt

ATGGAAAAACTACGTTCCTATGAGGATTTCATCTTCATGGCCAACATGATGTTCAAGA
CCCTTGGCTACGATCTATTCCATACACCCAAACCCTGGTGGCGCTATCTGCTTGTGCG
AGGATACTTCGTTTTGTGCACGATCAGCAACTTTTACGAGGCTTCCATGGTGACGACA
AGGATAATTGAGTGGGAATCCTTGGCCGGAAGTCCCTCCAAAATAATGCGACAGGGTC
TGCACTTCTTTTACATGTTGAGTAGCCAATTGAAATTTATCACATTCATGATAAATCG
CAAACGCCTACTGCAGCTGAGCCATCGTTTGAAAGAGTTGTATCCTCATAAAGAGCAA
AATCAAAGGAAGTACGAGGTGAATAAATACTACCTATCCTGTTCCACGCGCAATGTTT
TGTACGTGTACTACTTTGTAATGGTCGTCATGGCACTGGAACCCCTCGTTCAGTCCCA
GTTCATAGTGAATGTGAGCCTGGGCACAGATCTGTGGATGATGTGCGTCTCAAGCCAA
ATATCGATGCACTTGGGCTATCTGGCCAATATGTTGGCCTCCATTCGACCAAGTCCAG
AAACGGAACAACAAGACTGTGACTTCTTGGCCAGCATTATAAAGAGACATCAACTAAT
GATCAGGCTTCAAAAGGACGTGAACTATGTTTTTGGACTCTTATTGGCATCTAATCTG
TTTACCACATCCTGTTTACTTTGCTGCATGGCGTACTATACCGTCGTCGAAGGTTTCA
ATTGGGAGGGCATTTCCTATATGATGCTCTTTGCTAGTGTAGCTGCCCAGTTCTACGT
TGTCAGCTCACACGGACAAATGTTAATAGATTTGTTGATGACCATCACATACAGATTT
TTCGCGGTTATACGACAAACTGTAGAAAAG

DOR104

MASLQFHGNVDADIRYDISLDPARESNLFRLLMGLQLANGTKPSPRLPKWWPKRLEMI
GKVLPKAYCSMVIFTSLHLGVLFTKTTLDVLPTGELQAITDALTMTIIYFFTGYGTIY
WCLRSRRLLAYMEHMNREYRHHSLAGVTFVSSHAAFRMSRNFTVVWIMSCLLGVISWG
VSPLMLGIRMLPLQCWYPFDALGPGTYTAVYATQLFGQIMVGMTFGFGGSLFVTLSLL
LLGQFDVLYCSLKNLDAHTKLLGGESVNGLSSLQEELLLGDSKRELNQYVLLQEHPTD
LLRLSAGRKCPDQGNAFHNALVECIRLHRFILHCSQELENLFSPYCLVKSLQITFQLC
LLVFVGVSGTREVLRIVNQLQYLGLTIFELLMFTYCGELLSRHSIRSGDAFWRGAWWK
HAHFIRQDILIFLVNSRRAVHVTAGKFYVMDVNRLRSVITQAFSFLTLLQKLAAKKTE
SEL

DOR104nt

GAATTCGGCACGAGCAGTCGATGGCCAGTCTTCAGTTCCACGGCAACGTCGATGCGGA
CATCAGGTATGATATTAGCCTGGATCCGGCTAGGGAATCGAATCTCTTCCGTCTGCTA
ATGGGACTCCAGTTGGCGAATGGCACGAAGCCATCGCCGCGGTTACCCAAATGGTGGC
CAAAGCGGCTGGAAATGATTGGTAAAGTGCTGCCCAAAGCCTATTGTTCCATGGTGAT
TTTCACCTCCCTGCATTTGGGTGTCCTGTTCACGAAAACCACACTGGATGTCCTGCCG
ACGGGGGAGCTGCAGGCCATAACGGATGCCCTCACCATGACCATAATATACTTTTTCA
CGGGCTACGGCACCATCTACTGGTGCCTGCGCTCCCGGCGCCTCTTGGCCTACATGGA
GCACATGAACCGGGAGTATCGCCATCATTCGCTGGCCGGGGTGACCTTTGTGAGTAGC
CATGCGGCCTTTAGGATGTCCAGAAACTTCACGGTGGTGTGGATAATGTCCTGCCTGC
TGGGCGTGATTTCCTGGGGCGTTTCGCCACTGATGCTGGGCATCCGGATGCTGCCGCT
CCAATGTTGGTATCCCTTCGACGCCCTGGGTCCCGGCACATATACGGCGGTCTATGCT
ACACAACTTTTCGGTCAGATCATGGTGGGCATGACCTTTGGATTCGGGGGATCACTGT
TTGTCACCCTGAGCCTGCTACTCCTGGGACAATTCGATGTGCTCTACTGCAGCCTGAA
GAACCTGGATGCCCATACCAAGTTGCTGGGCGGGGAGTCTGTAAATGGCCTGAGTTCG
CTGCAAGAGGAGTTGCTGCTGGGGGACTCGAAGAGGGAATTAAATCAGTACGTTTTGC
TCCAGGAGCATCCGACGGATCTGCTGAGATTGTCGGCAGGACGAAAATGTCCTGACCA
AGGAAATGCGTTTCACAACGCCTTGGTGGAATGCATTCGCTTGCATCGCTTCATTCTG
CACTGCTCACAGGAGTTGGAGAATCTATTCAGTCCATATTGTCTGGTCAAGTCACTGC
AGATCACCTTTCAGCTTTGCCTGCTGGTCTTTGTGGGCGTTTCGGGTACTCGAGAGGT
CCTGCGGATTGTCAACCAGCTACAGTACTTGGGACTGACCATCTTCGAGCTCCTAATG
TTCACCTATTGTGGCGAACTCCTCAGTCGGCATAGTATTCGATCTGGCGACGCCTTTT
GGAGGGGTGCGTGGTGGAAGCACGCCCATTTCATCCGCCAGGACATCCTCATCTTTCT
GGTCAATAGTAGACGTGCAGTTCACGTGACTGCCGGCAAGTTTTATGTGATGGATGTG
AATCGTCTAAGATCGGTTATAACGCAGGCGTTCAGCTTCTTGACTTTGCTGCAAAAGT
TGGCTGCCAAGAAGACGGAATCGGAGCTCTAAACTGGTACCACGCATCGATATTTATT
TAGCGCATTAAAAAAAAGTCGAGTAAAAGCAAAAAAAAAAAAAAAAAAA

DOR105

MFEDIQLIYMNIKILRFWALLYDKNLRRYVCIGLASFHIFTQIVYMMSTNEGLTGIIR
NSYMLVLWINTVLRAYLLLADHDRYLALIQKLTEAYYDLLNLNDSYISEILDQVNKVG
KLMARGNLFFGMLTSMGFGLYPLSSSERVLPFGSKIPGLNEYESPYYEMWYIFQMLIT
PMGCCMYIPYTSLIVGLIMFGIVRCKALQHRLRQVALKHPYGDRDPRELREEIIACIR
YQQSIIEYMDHINELTTMMFLFELMAFSALLCALLFMLIIVSGTSQLIIVCMYINMIL
AQILALYWYANELREQNLAVATAAYETEWFTFDVPLRKNILFMMMRAQRPAAILLGNI
RPITLELFQNLLNTTYTFFTVLKRVYG

DOR105nt

ATGTTTGAAGACATTCAGCTAATCTACATGAATATCAAGATATTGCGATTCTGGGCCC
TGCTCTATGACAAAAACTTGAGGCGTTATGTGTGCATTGGACTGGCCTCATTCCACAT
CTTCACCCAAATCGTCTACATGATGAGTACCAATGAAGGACTAACCGGGATAATTCGT
AACTCATATATGCTCGTCCTTTGGATTAATACGGTGCTGCGAGCTTATCTCTTGCTGG
CGGATCACGACAGATATTTGGCTTTGATCCAAAAACTAACTGAGGCCTATTACGATTT
ACTGAATCTGAACGATTCGTATATATCGGAAATATTGGACCAGGTGAACAAGGTGGGA
AAGTTGATGGCTAGGGGCAATCTGTTCTTTGGCATGCTCACATCCATGGGATTCGGTC
TGTACCCATTGTCCTCCAGCGAAAGAGTCCTGCCATTTGGCAGCAAAATTCCTGGTCT
AAATGAGTACGAGAGTCCGTACTATGAGATGTGGTACATCTTTCAGATGCTCATCACC
CCGATGGGCTGTTGCATGTACATTCCGTACACCAGTCTGATTGTGGGCTTGATAATGT
TCGGCATTGTGAGGTGCAAGGCTTTGCAGCATCGCCTCCGCCAGGTGGCGCTTAAGCA
TCCGTACGGAGATCGCGATCCCCGTGAACTGAGGGAGGAGATCATAGCCTGCATACGT
TACCAGCAGAGCATTATCGAGTACATGGATCACATAAACGAGCTGACCACCATGATGT
TCCTATTCGAACTGATGGCCTTTTCGGCGCTGCTCTGTGCGCTGCTCTTTATGCTGAT
TATCGTCAGCGGCACCAGTCAGCTGATAATTGTTTGCATGTACATTAACATGATTCTG
GCCCAAATACTGGCCCTCTATTGGTATGCAAATGAGTTAAGGGAACAGAATCTGGCGG
TGGCCACCGCAGCCTACGAAACGGAGTGGTTCACCTTCGACGTTCCACTGCGCAAAAA
CATCCTGTTCATGATGATGAGGGCACAGCGGCCAGCTGCAATACTACTGGGCAATATA
CGCCCCATCACTTTGGAACTGTTCCAAAACCTACTGAACACAACCTATACATTTTTTA
CGGTTCTCAAGCGAGTCTACGGA

DOR107

MYPRFLSRNYPLAKHLFFVTRYSFGLLGLRFGKEQSWLHLLWLVFNFVNLAHCCQAEF
VFGWSHLRTSPVDAMDAFCPLACSFTTLFKLGWMWWRRQEVADLMDRIRLLIGEQEKR
EDSRRKVAQRSYYLMVTRCGMLVFTLGSITTGAFVLRSLWEMWVRRHQEFKFDMPFRM
LFHDFAHRMPWFPVFYLYSTWSGQVTVYAFAGTDGFFFGFTLYMAFLLQALRYDIQDA
LKPIRDPSLRESKICCQRLADIVDRHNEIEKIVKEFSGIMAAPTFVHFVSASLVIATS

VIDILLYSGYNIIRYVVYTFTVSSAIFLYCYGGTEMSTESLSLGEAAYSSAWYTWDRE
TRRRVFLIILRAQRPITVRVPFFAPSLPVFTSVIKFTGSIVALAKTIL

DOR107nt

ATGTATCCGCGATTCCTCAGCCGTAACTATCCGCTGGCCAAGCATTTGTTCTTCGTCA
CCAGATACTCCTTTGGCCTGCTGGGCCTGAGATTTGGCAAAGAGCAATCGTGGCTTCA
CCTCTTGTGGCTGGTGTTCAATTTCGTTAACCTGGCGCACTGCTGCCAGGCGGAGTTC
GTCTTCGGCTGGAGTCACTTGCGCACCAGTCCCGTGGATGCCATGGACGCCTTTTGTC
CTCTGGCCTGCAGTTTCACCACGCTCTTCAAGCTGGGATGGATGTGGTGGCGTCGCCA
GGAAGTAGCTGATCTAATGGACCGCATCCGCTTGCTCATCGGGGAGCAGGAGAAGAGG
GAGGACTCCCGGAGAAAGGTGGCTCAAAGGAGCTACTATCTCATGGTCACCAGGTGCG
GTATGCTGGTCTTCACCCTGGGCAGCATTACCACTGGAGCCTTCGTTCTGCGTTCCCT
TTGGGAAATGTGGGTGCGTCGTCATCAGGAGTTCAAATTCGATATGCCCTTTCGCATG
CTGTTCCACGACTTTGCGCATCGCATGCCCTGGTTTCCAGTTTTCTATCTCTACTCCA
CATGGAGTGGCCAGGTCACTGTGTACGCCTTTGCTGGTACAGATGGTTTCTTCTTTGG
CTTTACCCTCTACATGGCCTTCTTGCTGCAGGCCTTAAGATACGATATCCAGGATGCC
CTCAAGCCAATAAGAGATCCCTCGCTTAGGGAATCCAAAATCTGCTGTCAGCGATTGG
CGGACATCGTGGATCGCCACAATGAGATAGAGAAGATAGTCAAGGAATTTTCTGGAAT
TATGGCTGCTCCAACTTTTGTTCACTTCGTATCAGCCAGCTTAGTGATAGCCACCAGC
GTCATTGATATACTATTGTATTCCGGCTATAACATCATCCGTTACGTGGTGTACACCT
TCACGGTTTCCTCGGCCATCTTCCTCTATTGCTACGGAGGCACAGAAATGTCAACTGA
GAGCCTTTCCTTGGGAGAAGCAGCCTACAGCAGTGCCTGGTATACTTGGGATCGAGAG
ACCCGCAGGCGGGTCTTTCTCATTATCCTGCGTGCTCAACGACCCATTACGGTGAGGG
TGCCCTTTTTTGCACCATCGTTACCAGTCTTCACATCGGTCATCAAGTTTACAGGTTC
GATTGTGGCACTGGCTAAGACGATACTG

DOR108

MDKHKDRIESMRLILQVMQLFGLWPWSLKSEEEWTFTGFVKRNYRFLLHLPITFTFIG
LMWLEAFISSNLEQAGQVLYMSITEMALVVKILSIWHYRTEAWRLMYELQHAPDYQLH
NQEEVDFWRREQRFFKWFFYIYILISLGVVYSGCTGVLFLEGYELPFAYYVPFEWQNE
RRYWFAYGYDMAGMTLTCISNITLDTLGCYFLFHISLLYRLLGLRLRETKNMKNDTIF
GQQLRAIFIMHQRIRSLTLTCQRIVSPYILSQIILSALIICFSGYRLQHVGIRDNPGQ
FISMLQFVSVMILQIYLPCYYGNEITVYANQLTNEVYHTNWLECRPPIRKLLNAYMEH
LKKPVTIRAGNSFAVGLPIFVKTINNAYSFLALLLNVSN

DOR108nt

ATGGATAAACACAAGGATCGCATTGAATCCATGCGCCTAATTCTTCAGGTCATGCAAC
TATTTGGCCTCTGGCCGTGGTCCTTGAAATCGGAAGAGGAGTGGACTTTCACCGGTTT
TGTAAAGCGCAACTATCGCTTCCTGCTCCATCTGCCCATTACCTTCACCTTTATTGGA
CTCATGTGGCTGGAGGCCTTCATCTCGAGCAATCTGGAGCAGGCTGGCCAGGTTCTGT
ACATGTCCATCACCGAGATGGCTTTGGTGGTGAAAATCCTGAGCATTTGGCACTATCG
CACCGAAGCTTGGCGGCTGATGTACGAACTCCAACATGCTCCGGACTACCAACTCCAC
AACCAGGAGGAGGTAGACTTTTGGCGCCGGGAGCAACGATTCTTCAAGTGGTTCTTCT
ACATCTACATTCTGATTAGCTTGGGCGTGGTATATAGTGGCTGCACTGGAGTACTTTT
TCTGGAGGGCTACGAACTGCCCTTTGCCTACTACGTGCCCTTCGAATGGCAGAACGAG
AGAAGGTACTGGTTCGCCTATGGTTACGATATGGCGGGCATGACGCTGACCTGCATCT
CAAACATTACCCTGGACACCCTGGGTTGCTATTTCCTGTTCCATATCTCTCTTTTGTA
CCGACTGCTTGGTCTGCGATTGAGGGAAACGAAGAATATGAAGAATGATACCATTTTT
GGCCAGCAGTTGCGTGCCATCTTCATTATGCATCAGAGGATTAGAAGCCTAACCCTGA
CCTGCCAGAGAATCGTATCTCCCTATATCCTATCTCAGATCATTTTGAGTGCCCTGAT
CATCTGCTTTAGTGGATACCGCTTGCAGCATGTGGGAATTCGCGATAATCCCGGCCAG
TTTATATCCATGTTGCAGTTTGTCAGTGTGATGATCCTGCAGATTTACTTGCCCTGCT
ACTATGGAAACGAGATAACCGTGTATGCCAATCAGCTGACCAACGAGGTTTACCATAC
CAATTGGCTGGAATGTCGGCCACCGATTCGAAAGTTACTCAATGCCTACATGGAGCAC
CTGAAGAAACCGGTGACCATCCGGGCTGGCAACTCCTTCGCCGTGGGACTACCAATTT
TTGTTAAGACCATCAACAACGCCTACAGTTTCTTGGCTTTATTACTAAATGTATCGAA
T

DOR109

MESTNRLSAIQTLLVIQRWIGLLKWENEGEDGVLTWLKRIYPFVLHLPLTFTYIALMW
YEAITSSDFEEAGQVLYMSITELALVTKLLNIWYRRHEAASLIHELQHDPAFNLRNSE
EIKFWQQNQRNFKRIFYWYIWGSLFVAVMGYISVFFQEDYELPFGYYVPFEWRTRERY
FYAWGYNVVAMTLCCLSNILLDTLGCYFMFHIASLFRLLGMRLEALKNAAEEKARPEL
RRIFQLHTKVRRLTRECEVLVSPYVLSQVVFSAFIICFSAYRLVHMGFKQRPGLFVTT
VQFVAVMIVQIFLPCYYGNELTFHANALTNSVFGTNWLEYSVGTRKLLNCYMEFLKRP
VKVRAGVFFEIGLPIFVKTINNAYSFFALLLKISK

DOR109nt

ATGGAGTCTACAAATCGCCTAAGTGCCATCCAAACACTTTTAGTAATCCAACGTTGGA
TAGGACTTCTTAAATGGGAAAACGAGGGCGAGGATGGAGTATTAACCTGGCTAAAACG
AATATATCCTTTTGTACTGCACCTTCCACTGACCTTCACGTATATTGCCTTAATGTGG
TATGAAGCTATTACATCGTCAGATTTTGAGGAAGCTGGTCAAGTTCTGTACATGTCCA

TCACCGAACTGGCATTGGTCACTAAACTGCTGAATATTTGGTATCGTCGTCATGAAGC
TGCTAGTCTAATCCACGAATTGCAACACGATCCCGCATTTAATCTGCGCAATTCGGAG
GAAATCAAATTCTGGCAGCAAAATCAGAGGAACTTTAAGAGAATATTTTACTGGTACA
TCTGGGGCAGCCTTTTCGTGGCTGTAATGGGTTATATAAGCGTGTTTTTCCAGGAGGA
TTACGAGCTGCCCTTTGGCTACTACGTGCCATTCGAGTGGCGCACCAGGGAACGATAC
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TGCCTATCGACTGGTGCACATGGGCTTCAAGCAGCGACCTGGACTCTTCGTGACCACC
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AGTTGACCTTTCATGCCAATGCACTCACTAATAGTGTCTTCGGTACCAATTGGCTGGA
GTACTCCGTGGGCACTCGCAAGCTGCTTAACTGCTACATGGAGTTCCTCAAGCGACCG
GTTAAAGTGCGAGCTGGGGTGTTCTTTGAAATAGGACTACCCATCTTTGTGAAGACCA
TCAACAATGCCTACAGTTTCTTCGCCCTGCTGCTAAAGATATCCAAG

DOR110

MLFNYLRKPNPTNLLTSPDSFRYFEYGMFCMGWHTPATHKIIYYITSCLIFAWCAVYL
PIGIIISFKTDINTFTPNELLTVMQLFFNSVGMPFKVLFFNLYISGFYKAKKLLSEMD
KRCTTLKERVEVHQGVVRCNKAYLIYQFIYTAYTISTFLSAALSGKLPWRIYNPFVDF
RESRSSFWKAALNETALMLFAVTQTLMSDIYPLLYGLILRVHLKLLRLRVESLCTDSG
KSDAENEQDLINYAAAIRPAVTRTIFVQFLLIGICLGLSMINLLFFADIWTGLATVAY
INGLMVQTFPFCFVCDLLKKDCELLVSAIFHSNWINSSRSYKSSLRYFLKNAQKSIAF
TAGSIFPISTGSNIKVAKLAFSVVTFVNQLNIADRLTKN

DOR110nt

ATGTTGTTCAACTATCTGCGAAAGCCGAATCCCACAAACCTTTTGACTTCTCCGGACT
CATTTAGATACTTTGAGTATGGAATGTTTTGCATGGGATGGCACACACCAGCAACGCA
TAAGATAATCTACTATATAACATCCTGTTTGATTTTTGCTTGGTGTGCCGTATACTTG
CCAATCGGAATCATCATTAGTTTCAAAACGGATATTAACACATTCACACCGAATGAAC
TGTTGACAGTTATGCAATTATTTTTCAATTCAGTGGGAATGCCATTCAAGGTTCTGTT
CTTCAATTTGTATATTTCTGGATTTTACAAGGCCAAAAAGCTCCTTAGCGAAATGGAC
AAACGTTGCACCACTTTGAAGGAGCGAGTGGAAGTGCACCAAGGTGTGGTCCGTTGCA
ACAAGGCCTACCTCATTTACCAGTTCATTTATACCGCGTACACTATTTCAACATTTCT
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TTGCTGTGACTCAAACCCTAATGAGTGATATATATCCACTGCTTTATGGTTTGATCCT
GAGAGTTCACCTCAAACTTTTGCGACTAAGAGTGGAGAGCCTGTGCACAGATTCTGGA

AAAAGCGATGCTGAAAACGAGCAAGATTTGATTAACTATGCTGCAGCAATACGACCAG
CGGTTACCCGCACAATTTTCGTTCAATTCCTCTTGATCGGAATTTGCCTTGGCCTTTC
AATGATCAATCTACTCTTCTTTGCCGACATCTGGACAGGATTGGCCACAGTGGCTTAC
ATCAATGGTCTAATGGTGCAGACATTTCCATTTTGCTTCGTTTGTGATCTACTCAAAA
AGGATTGTGAACTTCTTGTGTCGGCCATATTTCATTCCAACTGGATTAATTCAAGCCG
CAGTTACAAGTCATCTTTGAGATATTTTCTGAAGAACGCCCAGAAATCAATTGCTTTT
ACAGCCGGCTCTATTTTTCCCATTTCTACTGGCTCGAATATTAAGGTGGCTAAGCTGG
CATTTTCGGTGGTTACTTTTGTCAATCAACTTAACATAGCTGACAGATTGACAAAGAA
C

DOR111

MLFRKRKPKSDDEVITFDELTRFPMTFYKTIGEDLYSDRDPNVIRRYLLRFYLVLGFL
NFNAYVVGEIAYFIVHIMSTTTLLEATAVAPCIGFSFMADFKQFGLTVNRKRLVRLLD
DLKEIFPLDLEAQRKYNVSFYRKHMNRVMTLFTILCMTYTSSFSFYPAIKSTIKYYLM
GSEIFERNYGFHILFPYDAETDLTVYWFSYWGLAHCAYVAGVSYVCVDLLLIATITQL
TMHFNFIANDLEAYEGGDHTDEENIKYLHNLVVYHARALDINKKCTFQSSRIGHSAFN
QNWLPCSTKYKRILQFIIARSQKPASIRPPTFPPISFNTFMKVISMSYQFFALLRTTY
YG

DOR111nt

ATGCTGTTCCGCAAACGTAAGCCAAAAAGTGACGATGAAGTCATCACCTTCGACGAAC
TTACCCGGTTTCCGATGACTTTCTACAAGACCATCGGCGAGGATCTGTACTCCGATAG
GGATCCGAATGTGATAAGGCGTTACCTGCTACGTTTTTATCTGGTACTCGGTTTTCTC
AACTTCAATGCCTATGTGGTGGGCGAAATCGCGTACTTTATAGTCCATATAATGTCGA
CGACTACTCTTTTGGAGGCCACTGCAGTGGCACCGTGCATTGGCTTCAGCTTCATGGC
CGACTTTAAGCAGTTCGGTCTCACAGTGAATAGAAAGCGATTGGTCAGATTGCTGGAT
GATCTCAAGGAGATATTTCCTTTAGATTTAGAAGCGCAGCGGAAGTATAACGTATCGT
TTTACCGGAAACACATGAACAGGGTCATGACCCTATTCACCATCCTCTGCATGACCTA
CACCTCGTCATTTAGCTTTTATCCAGCCATCAAGTCGACCATAAAGTATTACCTTATG
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AAACGGATCTGACGGTCTACTGGTTTTCCTACTGGGGATTGGCTCATTGTGCCTATGT
GGCCGGAGTTTCCTACGTCTGCGTGGATCTCCTGCTGATCGCGACCATAACCCAGCTG
ACCATGCACTTCAACTTTATAGCGAATGATTTGGAGGCCTACGAAGGAGGTGATCATA
CGGATGAAGAAAATATCAAATACCTGCACAACTTGGTCGTCTATCATGCCAGGGCGCT
GGATATTAACAAGAAATGTACATTTCAGAGCTCTCGGATTGGCCATTCGGCATTTAAT
CAGAACTGGTTGCCATGCAGCACCAAATACAAACGCATCCTGCAATTTATTATCGCGC
GCAGCCAGAAGCCCGCCTCTATAAGACCGCCTACCTTTCCACCCATATCTTTTAATAC
CTTTATGAAGGTAATCAGCATGTCGTATCAGTTTTTTGCACTGCTCCGCACCACATAT

TATGGT

DOR114

MLTKKDTQSAKEQEKLKAIPLHSFLKYANVFYLSIGMMAYDHKYSQKWKEVLLHWTFI
AQMVNLNTVLISELIYVFLAIGKGSNFLEATMNLSFIGFVIVGDFKIWNISRQRKRLT
QVVSRLEELHPQGLAQQEPYNIGHHLSGYSRYSKFYFGMHMVLIWTYNLYWAVYYLVC
DFWLGMRQFERMLPYYCWVPWDWSTGYSYYFMYISQNIGGQACLSGQLAADMLMCALV
TLVVMHFIRLSAHIESHVAGIGSFQHDLEFLQATVAYHQSLIHLCQDINEIFGVSLLS
NFVSSSFIICFVGFQMTIGSKIDNLVMLVLFLFCAMVQVFMIATHAQRLVDASEQIGQ
AVYNHDWFRADLRYRKMLILIIKRAQQPSRLKATMFLNISLVTVSDLLQLSYKFFALL
RTMYVN

DOR114nt

ATGTTGACTAAGAAGGATACTCAAAGTGCCAAGGAGCAGGAAAAGTTGAAGGCCATTC
CATTGCACAGCTTTCTGAAATATGCCAACGTGTTCTATTTATCGATTGGAATGATGGC
CTACGATCACAAGTACAGTCAAAAGTGGAAGGAGGTCCTGCTGCACTGGACATTCATT
GCCCAGATGGTCAATCTGAATACAGTGCTCATCTCGGAACTGATTTACGTATTCCTGG
CGATCGGCAAAGGTAGCAATTTTCTGGAGGCCACCATGAATCTGTCTTTCATTGGATT
TGTCATCGTTGGTGACTTCAAAATCTGGAACATTTCGCGGCAGAGAAAGAGACTCACC
CAAGTGGTCAGCCGATTGGAAGAACTGCATCCGCAAGGCTTGGCTCAACAAGAACCCT
ATAATATAGGGCATCATCTGAGCGGCTATAGCCGATATAGCAAATTTTACTTCGGCAT
GCACATGGTGCTGATATGGACGTACAACCTGTATTGGGCCGTTTACTATCTGGTCTGT
GATTTCTGGCTGGGAATGCGTCAATTTGAGAGGATGCTGCCCTACTACTGCTGGGTTC
CCTGGGATTGGAGTACCGGATATAGCTACTATTTCATGTATATCTCACAGAATATCGG
CGGTCAGGCTTGTCTGTCCGGTCAGCTAGCAGCTGACATGTTAATGTGCGCCCTGGTC
ACTTTGGTGGTGATGCACTTCATCCGGCTTTCCGCTCACATCGAGAGTCATGTTGCGG
GCATTGGCTCATTCCAGCACGATTTGGAGTTCCTCCAAGCGACGGTGGCGTATCACCA
GAGCTTGATCCACCTCTGCCAGGATATCAATGAGATATTCGGTGTTTCACTGTTGTCC
AACTTTGTATCCTCGTCGTTTATCATCTGCTTCGTGGGTTTCCAGATGACCATCGGCA
GCAAGATCGACAACCTGGTAATGCTTGTGCTTTTCCTGTTTTGTGCCATGGTTCAGGT
CTTCATGATTGCCACCCATGCTCAGAGGCTCGTTGATGCGAGTGAACAGATTGGTCAA
GCGGTCTATAATCACGACTGGTTCCGTGCTGATCTGCGGTATCGTAAAATGCTGATCC
TGATTATTAAGAGGGCCCAACAGCCGAGTCGACTCAAGGCCACAATGTTCCTGAACAT
CTCACTGGTCACCGTGTCGGATCTCTTGCAACTCTCGTACAAATTCTTTGCCCTTCTG
CGCACAATGTACGTGAAT

DOR115

MEKLMKYASFFYTAVGIRPYTNGEESKMNKLIFHIVFWSNVINLSFVGLFESIYVYSA
FMDNKFLEAVTALSYIGFVTVGMSKMFFIRWKKTAITELINELKEIYPNGLIREERYN
LPMYLGTCSRISLIYSLLYSVLIWTFNLFCVMEYWVYDKWLNIRVVGKQLPYLMYIPW
KWQDNWSYYPLLFSQNFAGYTSAAGQISTDVLLCAVATQLVMHFDFLSNSMERHELSG
DWKKDSRFLVDIVRYHERILRLSDAVNDIFGIPLLLNFMVSSFVICFVGFQMTVGVPP
DIVVKLFLFLVSSMSQVYLICHYGQLVADASYGFSVATYNQKWYKADVRYKRALVIII
ARSQKVTFLKATIFLDITRSTMTDVRNCVLSV

DOR115nt

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TTCATGGATAATAAGTTCCTGGAAGCAGTCACTGCGTTGTCCTACATTGGCTTCGTAA
CCGTAGGCATGAGCAAGATGTTCTTCATCCGGTGGAAGAAAACGGCTATAACTGAACT
GATTAATGAATTGAAGGAGATCTATCCGAATGGTTTGATCCGAGAGGAAAGATACAAT
CTGCCGATGTATCTGGGCACCTGCTCCAGAATCAGCCTTATATATTCCTTGCTCTACT
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CCACTATGACAGATGTACGCAACTGTGTATTGTCAGTG

DOR116

MELLPLAMLMYDGTRVTAMQYLIPGLPLENNYCYVVTYMIQTVTMLVQGVGFYSGDLF
VFLGLTQILTFADMLQVKVKELNDALEQKAEYRALVRVGASIDGAENRQRLLLDVIRW
HQLFTDYCRAINALYYELIATQVLSMALAMMLSFCINLSSFHMPSAIFFVVSAYSMSI
YCILGTILEFAYDQVYESICNVTWYELSGEQRKLFGFLLRESQYPHNIQILGVMSLSV
RTALQIVKLIYSVSMMMMNRA

DOR116nt

ATGGAACTCCTGCCATTGGCCATGCTAATGTACGATGGAACCCGGGTTACTGCGATGC
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GGGCG

DOR117

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PFLDWRSSTLHLALQAGLEYFAMAGACFQDVCVDCYPVNFVLVLRAHMSIFAERLRRL
GTYPYESQEQKYERLVQCIQDHKVILRFVDCLRPVISGTIFVQFLVVGLVLGFTLINI
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DOR117nt

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CATCTTCGTGCAATTCTTGGTTGTGGGGTTGGTGCTGGGCTTTACCCTAATTAACATT
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TGTTTCCAATATCTGTGGGAACTAACATCAGTGTAAGCAGATGTGCCCTT

DOR118

MKFIGWLPPKQGVLRYVYLTWTLMTFVWCTTYLPLGFLGSYMTQIKSFSPGEFLTSLQ
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IIKPVIQGTIFTQFLLIGLVLGFTLINVFFFSDIWTGIASFMFVITILLQTFPFCYTC
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DOR118nt

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GTGGCAAAGTTTGCTTTCTCCGTGATAACCATTACCAAGCAAATGAATATAGCTGACA
AATTTAAGACGGAC

DOR119

MAVFKLIKPAPLTEKVQSRQGNIYLYRAMWLIGWIPPKEGVLRYVYLFWTCVPFAFGV
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DPERSEADNYQDLVNCVLDHKTILKCCDMIRPMISRTIFVQFALIGSVLGLTLVNVFF
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DOR120

MTKFFFKRLQTAPLDQEVSSLDASDYYYRIAFFLGWTPPKGALLRWIYSLWTLTTMWL
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PLVDWRKGHWQLWIASILEYCVVSIGTMQELMSDTYAIVFISLFRCHLAILRDRIANL
RQDPKLSEMEHYEQMVACIQDHRTIIQCSQIIRPILSITIFAQFMLVGIDLGLAAISI
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GDINP

DOR120nt

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DOR121

MLTDKFLRLQSALFRLLGLELLHEQDVGHRYPWRSICCILSVASFMPLTIAFGLQNVQ
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ESRRDQFISAMYAYCFITAGLSACLMSPLSMLISYHEQVNCSRNFHFPVCKKKYCLIS
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CYQLSANILQPALLFYAAFTAAVVGQVSIYCFCGSSIHSECQLFGQAIYESSWPHLLQ
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DOR121

ATGCTGACGGACAAGTTCCTCCGACTGCAGTCCGCTTTATTTCGCCTTCTCGGACTCG
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TCTCTCGGTGGCCAGTTTCATGCCCCTGACCATTGCGTTTGGCCTGCAAAACGTCCAA
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AGCGTTTATAAAAGTGTCCAAAAAGACACCTCAAGTGAATGAT

DOR14

MDYDRIRPVRFLTGVLKWWRLWPRKESVSTPDWTNWQAYALHVPFTFLFVLLLWLEAI
KSRDIQHTADVLLICLTTTALGGKVINIWKYAHVAQGILSEWSTWDLFELRSKQEVDM
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IGLPLFTKVVFSTLENPCISYLYFRP

DOR14nt

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GTTATCTTTATTTCAGACCA

DOR16

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FADLHGDSVDVFTEEMNAEVRHRLAQVVERHNAIIDFCTDLTRQFTVIVLMHFLSAAF
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DOR16nt

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DOR19

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CIYQLVMLWQIFIICYASNEVTVQSSRLCHSIYSSQWTGWNRANRRIVLLMMQRFNSP
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DOR19nt

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TTATGCACGTACAT

DOR20

MSKGVEIFYKGQKAFLNILSLWPQIERRWRIIHQVNYVHVIVFWVLLFDLLLVLHVMA
NLSYMSEVVKAIFILATSAGHTTKLLSIKANNVQMEELFRRLDNEEFRPRGANEELIF
AAACERSRKLRDFYGALSFAALSMILIPQFALDWSHLPLKTYNPLGENTGSPAYWLLY
CYQCLALSVSCITNIGFDSLCSSLFIFLKCQLDILAVRLDKIGRLITTSGGTVEQQLK
ENIRYHMTIVELSKTVERLLCKPISVQIFCSVLVLTANFYAIAVVSCEFATRRLSVCD
LSGVHVDSDFYIVLLCRVGIPYPKCLPRPVMNFIVSEVTQRSLDLPHELYKTSWVDWD
YRSRRIALLFMQRLHSTLRIRTLNPSLGFDLMLFSSVSSFRVLTFLCTVANFHNEAH

DOR20nt

ATGAGCAAAGGAGTAGAAATCTTTTACAAGGGCCAGAAGGCATTCTTGAACATCCTCT
CGTTGTGGCCTCAGATAGAACGCCGGTGGAGAATCATCCACCAGGTGAACTATGTCCA
CGTAATTGTGTTTTGGGTGCTGCTCTTTGATCTCCTCTTGGTGCTCCATGTGATGGCT
AATTTGAGCTACATGTCCGAGGTTGTGAAAGCCATCTTTATCCTGGCCACCAGTGCAG
GGCACACCACCAAGCTGCTGTCCATAAAGGCGAACAATGTGCAGATGGAGGAGCTCTT
TAGGAGATTGGATAACGAAGAGTTCCGTCCTAGAGGCGCCAACGAAGAGTTGATCTTT
GCAGCAGCCTGTGAAAGAAGTAGGAAGCTTCGGGACTTCTATGGAGCGCTTTCGTTTG
CCGCCTTGAGCATGATTCTCATACCCCAGTTCGCCTTGGACTGGTCCCACCTTCCGCT
CAAAACATACAATCCGCTTGGCGAGAATACCGGCTCACCTGCTTATTGGCTCCTCTAC
TGCTATCAGTGTCTGGCCTTGTCCGTATCCTGCATCACCAACATAGGATTCGACTCAC
TCTGCTCCTCACTGTTCATCTTCCTCAAGTGCCAGCTGGACATTCTGGCCGTGCGACT
GGACAAGATCGGTCGGTTAATCACTACTTCTGGTGGCACTGTGGAACAGCAACTTAAG
GAAAATATCCGCTATCACATGACCATCGTTGAACTGTCGAAAACCGTGGAGCGTCTAC
TTTGCAAGCCGATTTCGGTGCAGATCTTCTGCTCGGTTTTGGTGCTGACTGCCAATTT
CTATGCCATTGCTGTGGTGAGCTGTGAATTCGCAACAAGAAGACTATCAGTATGTGAC
CTATCAGGCGTGCATGTTGATTCAGATTTTTATATTGTGCTACTATGCCGGGTGGGTA

TTCCATATCCGAAATGCCTCCCCAGGCCAGTAATGAATTTCATCGTCAGTGAGGTAAC
CCAGCGCAGCCTGGACCTTCCGCACGAGCTGTACAAGACCTCCTGGGTGGACTGGGAC
TACAGGAGCCGAAGGATTGCGCTCCTCTTTATGCAACGCCTTCACTCGACCTTGAGGA
TTAGGACACTTAATCCAAGTCTTGGTTTTGACTTAATGCTCTTCAGCTCGGTGAGTTC
TTTCCGTGTTTTGACTTTTTTGTGCACTGTAGCCAATTTCCATAATGAGGCTCAT

DOR24

MDSFLQVQKSTIALLGFDLFSENREMWKRPYRAMNVFSIAAIFPFILAAVLHNWKNVL
LLADAMVALLITILGLFKFSMILYLRRDFKRLIDKFRLLMSNEAEQGEEYAEILNAAN
KQDQRMCTLFRTCFLLAWALNSVLPLVRMGLSYWLAGHAEPELPFPCLFPWNIHIIRN
YVLSFIWSAFASTGVVLPAVSLDTIFCSFTSNLCAFFKIAQYKVVRFKGGSLKESQAT
LNKVFALYQTSLDMCNDLNQCYQPIICAQFFISSLQLCMLGYLFSITFAQTEGVYYAS
FIATIIIQAYIYCYCGENLKTESASFEWAIYDSPWHESLGAGGASTSICRSLLISMMR
AHRGFRITGYFFEANMEAFSSIVRTAMSYITMLRSFS

DOR24nt

GGCACGAGCCTTGTCGACATGGACAGTTTTCTGCAAGTACAGAAGAGCACCATTGCTC
TTCTGGGCTTTGATCTCTTTAGTGAAAATCGAGAAATGTGGAAACGCCCCTATAGAGC
AATGAATGTGTTTAGCATAGCTGCCATTTTTCCCTTTATCCTGGCAGCTGTGCTCCAT
AATTGGAAGAATGTATTGCTGCTGGCCGATGCCATGGTGGCCCTACTAATAACCATTC
TGGGCCTATTCAAGTTTAGCATGATACTTTACTTACGTCGCGATTTCAAGCGACTGAT
TGACAAATTTCGTTTGCTCATGTCGAATGAGGCGGAACAGGGCGAGGAATACGCCGAG
ATTCTCAACGCAGCAAACAAGCAGGATCAACGAATGTGCACTCTGTTTAGGACTTGTT
TCCTCCTCGCCTGGGCCTTGAATAGTGTTCTGCCCCTCGTGAGAATGGGTCTCAGCTA
TTGGTTAGCAGGTCATGCAGAGCCCGAGTTGCCTTTTCCCTGTCTTTTTCCCTGGAAT
ATCCACATCATTCGCAATTATGTTTTGAGCTTCATCTGGAGCGCTTTCGCCTCGACAG
GTGTGGTTTTACCTGCTGTCAGCTTGGATACCATATTCTGTTCCTTCACCAGCAACCT
GTGCGCCTTCTTCAAAATTGCGCAGTACAAGGTGGTTAGATTTAAGGGCGGATCCCTT
AAAGAATCACAGGCCACATTGAACAAAGTCTTTGCCCTGTACCAGACCAGCTTGGATA
TGTGCAACGATCTGAATCAGTGCTACCAACCGATTATCTGCGCCCAGTTCTTCATTTC
ATCTCTGCAACTCTGCATGCTGGGATATCTGTTCTCCATTACTTTTGCCCAGACAGAG
GGCGTGTACTATGCCTCTTTCATAGCCACCATCATTATACAAGCCTATATCTACTGCT
ACTGCGGGGAGAACCTGAAGACGGAGAGTGCCAGCTTCGAGTGGGCCATCTACGACAG
TCCGTGGCACGAGAGTTTGGGTGCTGGTGGAGCCTCTACCTCGATCTGCCGATCCTTG
CTGATCAGCATGATGCGGGCTCATCGGGGATTCCGCATTACGGGATACTTCTTCGAGG
CAAACATGGAGGCCTTCTCATCGATTGTTCGCACGGCTATGTCCTACATCACAATGCT
GAGATCATTCTCCTAAATGTGGTTTGACCACAAGGCTTTGGATTGATTTTTGTGCAAT

TTTTGTTTTATTGCTGAGCATGCGTTGCCGTACGACATTTAACAATCGATCTTACGTA
ATTTACATATGATAATCTCACATATTGTTCGTTAAGCACTAAGTAGAATGTAGAATGT
GAATTGGCTGTAGAAATGCACAGATGAAGCACGAAAAAAAAAAAAAAAAAAAAAAA

DOR25

MNDSGYQSNLSLLRVFLDEFRSVLRQESPGLIPRLAFYYVRAFLSLPLYRWINLFIMC
NVMTIFWTMFVALPESKNVIEMGDDLVWISGMALVFTKIFYMHLRCDEIDELISDFEY
YNRELRPHNIDEEVLGWQRLCYVIESGLYINCFCLVNFFSAAIFLQPLLGEGKLPFHS
VYPFQWHRLDLHPYTFWFLYIWQSLTSQHNLMSILMVDMVGISTFLQTALNLKLLCIE
IRKLGDMEVSDKRFHEEFCRVVRFHQHIIKLVGKANRAFNGAFNAQLMASFSLISIST
FETMAAAAVDPKMAAKFVLLMLVAFIQLSLWCVSGTLVYTQSVEVAQAAFDINDWHTK
SPGIQRDISFVILRAQKPLMYVAEPFLPFTLGTYMLVLKNCYRLLALMQESM

DOR25nt

ATGAACGACTCGGGTTATCAATCAAATCTCAGCCTTCTGCGGGTTTTTCTCGACGAGT
TCCGATCGGTTCTGCGGCAGGAAAGTCCCGGTCTCATCCCACGCCTGGCTTTTTACTA
TGTTCGCGCCTTTCTGAGCTTGCCCCTGTACCGATGGATCAACTTGTTCATCATGTGC
AATGTGATGACCATTTTCTGGACCATGTTCGTGGCCCTGCCCGAGTCGAAGAACGTGA
TCGAAATGGGCGACGACTTGGTTTGGATTTCGGGGATGGCACTGGTGTTCACCAAGAT
CTTTTACATGCATTTGCGTTGCGACGAGATCGATGAACTTATTTCGGATTTTGAATAC
TACAACCGGGAGCTGAGACCCCATAATATCGATGAGGAGGTGTTGGGTTGGCAGAGAC
TGTGCTACGTGATAGAATCGGGTCTATATATCAACTGCTTTTGCCTGGTCAACTTCTT
CAGTGCCGCTATTTTCCTGCAACCTCTGTTGGGCGAGGGAAAGCTGCCCTTCCACAGC
GTCTATCCGTTTCAATGGCATCGCTTGGATCTGCATCCCTACACGTTCTGGTTCCTCT
ACATCTGGCAGAGTCTGACCTCGCAGCACAACCTAATGAGCATTCTAATGGTGGATAT
GGTAGGCATTTCCACGTTCCTCCAGACGGCGCTCAATCTCAAGTTGCTTTGCATCGAG
ATAAGGAAACTGGGGGACATGGAGGTCAGTGATAAGAGGTTCCACGAGGAGTTTTGTC
GTGTGGTTCGCTTCCACCAGCACATTATCAAGTTGGTGGGGAAAGCCAATAGAGCTTT
CAATGGCGCCTTCAATGCACAATTAATGGCCAGTTTCTCCCTGATTTCCATATCCACT
TTCGAGACCATGGCTGCAGCGGCTGTGGATCCCAAAATGGCCGCCAAGTTCGTGCTTC
TCATGCTGGTGGCATTCATTCAACTGTCGCTTTGGTGCGTCTCTGGAACTTTGGTTTA
TACTCAGTCAGTGGAGGTGGCTCAGGCTGCTTTTGATATCAACGATTGGCACACCAAA
TCGCCAGGCATCCAGAGGGATATATCCTTTGTGATACTACGAGCCCAGAAACCCCTGA
TGTATGTGGCCGAACCATTTCTGCCCTTCACCCTGGGAACCTATATGCTTGTACTGAA
GAACTGCTATCGTTTGCTGGCCCTGATGCAAGAATCGATGTAG

DOR28

MYSPEEAAELKRRNYRSIREMIRLSYTVGFNLLDPSRCGQVLRIWTIVLSVSSLASLY
GHWQMLARYIHDIPRIGETAGTALQFLTSIAKMWYFLFAHRQIYELLRKARCHELLQK
CELFERMSDLPVIKEIRQQVESTMNRYWASTRRQILIYLYSCICITTNYFINSFVINL
YRYFTKPKGSYDIMLPLPSLYPAWEHKGLEFPYYHIQMYLETCSLYICGMCAVSFDGV
FIVLCLHSVGLMRSLNQMVEQATSELVPPDRRVEYLRCCIYQYQRVANFATEVNNCFR
HITFTQFLLSLFNWGLALFQMSVGLGNNSSITMIRMTMYLVAAGYQIVVYCYNGQRFA
TASEEIANAFYQVRWYGESREFRHLIRMMLMRTNRGFRLDVSWFMQMSLPTLMAVSSG
AEQSRGPAGPAGPAGPPPRVPSYSQFHLIDSQMVRTSGQYFLLLQNVNQK

DOR28nt

ATGTACTCACCGGAAGAGGCGGCCGAACTGAAGAGGCGCAACTATCGCAGCATCAGG
GAGATGATCCGACTCTCCTATACGGTGGGCTTCAACCTGTTGGATCCTTCCCGATGCG
GACAGGTGCTCAGAATCTGGACAATTGTCCTTAGCGTGAGTAGCTTGGCATCGCTTTA
TGGGCACTGGCAAATGTTAGCCAGGTACATTCATGATATTCCACGCATTGGAGAGACC
GCTGGAACTGCCCTGCAGTTCCTAACATCGATAGCAAAGATGTGGTACTTTCTGTTTG
CCCATAGACAGATATACGAATTGCTACGAAAGGCGCGCTGCCATGAATTACTCCAAAA
GTGTGAGCTCTTTGAAAGGATGTCAGATCTACCTGTTATCAAAGAGATTCGCCAGCAG
GTTGAGTCCACGATGAATCGGTACTGGGCCAGCACTCGTCGGCAAATTCTTATCTATT
TGTACAGCTGTATTTGTATTACTACAAACTACTTTATCAACTCCTTCGTAATCAACCT
CTATCGCTATTTCACTAAACCGAAAGGATCCTACGACATAATGTTACCTCTGCCATCT
CTGTATCCCGCCTGGGAGCACAAGGGATTAGAGTTTCCCTACTATCATATACAGATGT
ACCTGGAAACCTGTTCTCTGTATATCTGCGGCATGTGTGCCGTTAGCTTTGATGGAGT
CTTTATTGTCCTGTGCCTTCATAGCGTGGGACTTATGAGGTCACTTAACCAAATGGTG
GAACAAGCCACATCTGAGTTGGTTCCTCCAGATCGCAGGGTTGAATACTTGCGATGCT
GTATTTATCAGTACCAACGAGTGGCGAACTTTGCAACCGAGGTTAACAACTGCTTTCG
GCACATCACTTTCACGCAGTTCCTGCTTAGCCTTTTCAACTGGGGCCTGGCCTTGTTC
CAAATGAGCGTCGGATTGGGCAACAACAGCAGCATCACCATGATCCGGATGACCATGT
ACCTGGTGGCAGCCGGCTATCAGATAGTTGTGTACTGCTACAATGGCCAGCGATTTGC
GACTGCTAGCGAGGAGATTGCCAACGCCTTTTACCAGGTGCGATGGTACGGAGAGTCC
AGGGAGTTCCGCCACCTCATCCGCATGATGCTGATGCGCACGAACCGGGGATTCAGGC
TGGACGTGTCCTGGTTCATGCAAATGTCCTTGCCCACACTCATGGCGGTGAGTAGCGG
AGCAGAGCAGAGCAGGGGTCCTGCAGGTCCTGCAGGTCCTGCAGGTCCACCCCCAAGG
GTCCCCTCCTACAGCCAGTTCCACTTGATTGATTCGCAGATGGTCCGGACAAGTGGAC
AGTACTTCCTGCTGCTGCAGAACGTCAACCAGAAA

DOR30

MAVSTRVATKQEVPESRRAFRNLFNCFYALGMQAPDGSRPTTSSTWQRIYACFSVVMY
VWQLLLVPTFFVISYRYMGGMEITQVLTSAQVAIDAVILPAKIVALAWNLPLLRRAEH
HLAALDARCREQEEFQLILDAVRFCNYLVWFYQICYAIYSSSTFVCAFLLGQPPYALY
LPGLDWQRSQMQFCIQAWIEFLIMNWTCLHQASDDVYAVIYLYVVRIQVQLLARRVEK
LGTDDSGQVEIYPDERRQEEHCAELQRCIVDHQTMLQLLDCISPVISRTIFVQFLITA
AIMGTTMINIFIFANTNTKIASIIYLLAVTLQTAPCCYQATSLMLDNERLALAIFQCQ
WLGQSARFRKMLLYYLHRAQQPITLTAMKLFPINLATYFSIAKFSFSLYTLIKGMNLG
ERFNRTN

DOR30nt

ATGGCGGTGAGCACTCGTGTGGCCACAAAGCAGGAAGTGCCCGAATCCCGGCGAGCGT
TTAGGAATCTCTTCAATTGCTTCTATGCCCTTGGCATGCAGGCACCGGATGGCAGTCG
ACCGACCACGAGCAGCACATGGCAACGCATCTACGCCTGCTTCTCGGTGGTCATGTAC
GTGTGGCAACTGCTGCTGGTGCCCACATTCTTTGTGATCAGCTATCGGTACATGGGCG
GCATGGAGATTACCCAGGTGCTGACCTCCGCCCAGGTGGCCATCGATGCGGTCATTCT
GCCGGCCAAGATTGTGGCACTGGCGTGGAATTTGCCATTGCTGCGCAGAGCAGAGCAT
CATCTGGCCGCCTTGGATGCGCGGTGCAGGGAACAGGAGGAGTTCCAATTGATCCTCG
ATGCGGTGAGGTTTTGCAACTATCTGGTATGGTTCTACCAGATCTGCTATGCCATCTA
CTCCTCGTCGACATTTGTGTGCGCCTTCCTGCTGGGCCAACCGCCATATGCCCTCTAT
TTGCCTGGCCTCGATTGGCAGCGTTCCCAGATGCAGTTCTGCATCCAGGCCTGGATTG
AGTTCCTTATCATGAACTGGACGTGCCTGCACCAAGCTAGCGATGATGTGTACGCCGT
TATCTATCTGTATGTGGTCCGGATTCAAGTGCAATTGCTGGCCAGGCGGGTGGAGAAG
CTGGGCACGGATGATAGTGGCCAGGTGGAGATCTATCCCGATGAGCGGCGGCAGGAGG
AGCATTGCGCGGAACTGCAGCGCTGCATTGTAGATCACCAGACGATGCTGCAGCTGCT
CGACTGCATTAGTCCCGTCATCTCGCGTACCATATTCGTTCAGTTCCTGATCACCGCC
GCCATCATGGGCACCACCATGATCAACATTTTCATTTTCGCCAATACGAACACGAAGA
TCGCATCGATCATTTACCTGCTGGCGGTGACCCTGCAGACGGCTCCATGTTGCTATCA
GGCCACCTCGCTGATGTTGGACAACGAGAGGCTGGCCCTGGCCATCTTCCAGTGCCAG
TGGCTGGGCCAGAGTGCCCGGTTCCGTAAGATGCTGCTCTACTATCTTCATCGCGCCC
AGCAGCCCATCACGCTGACCGCCATGAAGCTGTTTCCCATCAATCTGGCCACGTACTT
CAGTATAGCCAAGTTCTCGTTTTCGCTCTACACGCTCATCAAGGGGATGAATCTCGGC
GAGCGATTCAACAGGACAAAT

DOR31

MIFKYIQEPVLGSLFRSRDSLIYLNRSIDQMGWRLPPRTKPYWWLYYIWTLVVIVLVF
IFIPYGLIMTGIKEFKNFTTTDLFTYVQVPVNTNASIMKGIIVLFMRRRFSRAQKMMD

AMDIRCTKMEEKVQVHRAAALCNRVVVIYHCIYFGYLSMALTGALVIGKTPFCLYNPL
VNPDDHFYLATAIESVTMAGIILANLILDVYPIIYVVVLRIHMELLSERIKTLRTDVE
KGDDQHYAELVECVKDHKLIVEYGNTLRPMISATMFIQLLSVGLLLGLAAVSMQFYNT
VMERVVSGVYTIAILSQTFPFCYVCEQLSSDCESLTNTLFHSKWIGAERRYRTTMLYF
IHNVQQSILFTAGGIFPICLNTNIKMAKFAFSVVTIVNEMDLAEKLRRE

DOR31nt

ATGATTTTTAAGTACATTCAAGAGCCAGTCCTTGGATCCTTATTTCGATCCCGGGATT
CGCTGATCTACTTAAACAGATCCATAGATCAAATGGGATGGAGACTGCCGCCACGAAC
TAAGCCGTACTGGTGGCTCTATTACATTTGGACATTGGTGGTCATAGTACTCGTCTTT
ATCTTTATACCCTATGGACTGATAATGACTGGAATAAAGGAGTTCAAGAACTTCACGA
CCACGGATCTGTTTACGTATGTCCAGGTGCCGGTTAACACCAATGCTTCGATCATGAA
GGGCATTATAGTGTTGTTTATGCGGCGGCGATTTTCAAGGGCTCAGAAGATGATGGAC
GCCATGGACATTCGATGCACCAAGATGGAGGAGAAAGTCCAGGTGCACCGAGCAGCAG
CCTTATGCAATCGTGTTGTTGTGATTTACCATTGCATATACTTCGGCTATCTATCCAT
GGCCTTAACCGGAGCTCTGGTGATTGGGAAGACTCCATTCTGTTTGTACAATCCACTG
GTTAACCCCGACGATCATTTCTATCTGGCCACTGCCATTGAATCGGTCACCATGGCTG
GCATTATTCTGGCCAATCTCATTTTGGACGTATATCCCATCATATATGTGGTCGTTCT
GCGGATCCACATGGAGCTCTTGAGTGAGCGAATCAAGACGCTGCGTACTGATGTGGAA
AAAGGCGACGATCAACATTATGCCGAGCTGGTGGAGTGTGTAAAGGATCACAAGCTAA
TTGTCGAATATGGAAACACTCTGCGTCCCATGATATCCGCCACGATGTTCATCCAACT
ACTATCCGTTGGCTTACTTTTGGGTCTGGCAGCGGTGTCCATGCAGTTCTATAACACC
GTAATGGAGCGTGTTGTCTCCGGGGTCTACACCATAGCCATTCTATCCCAGACCTTTC
CATTTTGCTATGTCTGTGAGCAGCTGAGCAGCGATTGCGAATCCCTGACCAACACACT
GTTCCATTCCAAGTGGATTGGAGCTGAGCGACGATACAGAACCACGATGTTGTACTTC
ATTCACAATGTTCAGCAGTCGATTTTGTTCACTGCGGGCGGAATTTTCCCCATATGTC
TAAACACCAATATAAAGATGGCCAAGTTCGCTTTCTCAGTGGTGACCATTGTAAATGA
GATGGACTTGGCCGAGAAATTGAGAAGGGAG

DOR32

MEPVQYSYEDFARLPTTVFWIMGYDMLGVPKTRSRRILYWIYRFLCLASHGVCVGVMV
FRMVEAKTIDNVSLIMRYATLVTYIINSDTKFATVLQRSAIQSLNSKLAELYPKTTLD
RIYHRVNDHYWTKSFVYLVIIYIGSSIMVVIGPIITSIIAYFTHNVFTYMHCYPYFLY
DPEKDPVWIYISIYALEWLHSTQMVISNIGADIWLLYFQVQINLHFRGIIRSLADHKP
SVKHDQEDRKFIAKIVDKQVHLVSLQNDLNGIFGKSLLLSLLTTAAVICTVAVYTLIQ
GPTLEGFTYVIFIGTSVMQVYLVCYYGQQVLDLSGEVAHAVYNHDFHDASIAYKRYLL
IIIIRAQQPVELNAMGYLSISLDTFKQLMSVSYRVITMLMQMIQ

DOR32nt

ATGGAACCTGTGCAGTACAGCTACGAGGATTTCGCTCGATTGCCCACGACGGTGTTCT
GGATCATGGGCTACGACATGCTGGGCGTTCCGAAGACCCGCTCTCGCAGGATACTATA
CTGGATATATCGTTTCCTCTGTCTCGCCAGCCATGGGGTCTGTGTAGGAGTCATGGTA
TTTCGTATGGTGGAGGCAAAGACCATTGACAATGTTTCGCTGATCATGCGGTATGCCA
CTCTGGTCACCTATATCATCAACTCGGATACGAAATTCGCAACTGTCTTACAAAGGAG
TGCAATTCAAAGTCTAAACTCAAAACTGGCCGAACTATATCCGAAGACCACGCTGGAC
AGGATCTATCACCGGGTGAATGATCACTATTGGACCAAGTCATTTGTATATTTGGTTA
TTATCTACATTGGTTCGTCGATTATGGTTGTTATTGGACCGATTATTACGTCGATTAT
AGCTTACTTCACGCACAACGTTTTCACCTACATGCACTGCTATCCGTACTTTTTGTAT
GATCCTGAGAAGGATCCGGTTTGGATCTACATCAGCATCTATGCTCTGGAATGGTTGC
ACAGCACACAGATGGTCATTTCGAACATTGGCGCGGATATCTGGCTGCTGTACTTTCA
GGTGCAGATAAATCTCCACTTCAGGGGCATTATACGATCACTGGCGGATCACAAGCCC
AGTGTGAAGCACGACCAGGAGGACAGGAAATTCATTGCGAAAATTGTCGACAAGCAGG
TGCACCTGGTCAGTTTGCAAAACGATCTGAATGGTATCTTTGGAAAATCGCTGCTTCT
AAGCCTGCTGACCACCGCAGCGGTTATCTGCACGGTGGCGGTGTACACTCTGATTCAG
GGTCCCACCTTGGAGGGCTTCACCTATGTGATCTTCATCGGGACTTCTGTGATGCAGG
TCTACCTGGTGTGCTATTACGGTCAGCAAGTTCTCGACTTGAGCGGCGAGGTGGCCCA
CGCCGTGTACAATCATGATTTTCACGATGCTTCTATAGCGTACAAGAGGTACCTGCTC
ATAATCATTATCAGGGCGCAGCAGCCCGTGGAACTTAATGCCATGGGCTACCTGTCCA
TTTCGCTGGACACCTTTAAACAGCTGATGAGCGTCTCCTACCGGGTTATAACCATGCT
CATGCAGATGATTCAG

DOR37

protein sequence is incomplete and is in progress
KVDSTRALVNHWRIFRIMGIHPPGKRTFWGRHYTAYSMVWNVTFHICIWVSFSVNLLQ
SNSLETFCESLCVTMPHTLYMLKLINVRRMRGQMISSHWLLRLLDKRLGCDDERQIIM
AGIERAEFIFRTIFRGLACTVVLGIIYISASSEPTLMYPTWIPWNWRDSTSAYLATAM
LHTTALMANATLVLNLSSYPGTYLILVSVHTKALALRVSKLGYGAPLPAVRMQAILVG
YIHDHQIILR*VSGNLISQCKNF*SISGVLTFIERRMYTHFGVPNIFIVIEDYYILFL
NYSLFKSLERSLSMTCFLQFFSTACAQCTICYFLLFGNVGIMRFMNMLFLLVILTTET
LLLCYTAELPCKEGESLLTAVYSCNWLSQSVNFRRLLLLMLARCQIPMILVSGVIVPI
SMKTF

DOR37nt

information on nucleotide sequence is in progress

DOR38

MRLIKISYSALNEVCVWLKLNGSWPLTESSRPWRSQSLLATAYIVWAWYVIASVGITI
SYQTAFLLNNLSDIIITTENCCTTFMGVLNFVRLIHLRLNQRKFRQLIENFSYEIWIP
NSSKNNVAAECRRRMVTFSIMTSLLACLIIMYCVLPLVEIFFGPAFDAQNKPFPYKMI
FPYDAQSSWIRYVMTYIFTSYAGICVVTTLFAEDTILGFFITYTCGQFHLLHQRIAGL
FAGSNAELAESIQLERLKRIVEKHNNIISANSV

DOR38nt

ATGCGTTTGATCAAAATTTCATATTCGGCACTTAATGAGGTGTGCGTTTGGCTGAAAC
TGAATGGTTCTTGGCCATTAACCGAATCATCGAGGCCATGGAGGAGCCAATCCTTATT
GGCCACCGCCTACATCGTGTGGGCGTGGTACGTCATTGCATCTGTGGGCATAACAATC
AGCTATCAGACGGCCTTTTTGCTGAACAACCTTTCGGACATTATTATCACCACGGAAA
ATTGTTGCACCACCTTTATGGGTGTCCTGAACTTTGTCCGACTCATCCATCTTCGCCT
CAATCAGAGGAAATTCCGCCAGCTTATTGAGAACTTTTCCTACGAAATTTGGATACCT
AATTCTTCCAAAAACAATGTTGCCGCCGAGTGTCGCAGACGCATGGTTACCTTCAGCA
TAATGACATCCTTGCTAGCGTGCCTGATCATAATGTATTGTGTCCTGCCGCTGGTGGA
GATCTTCTTTGGACCCGCCTTCGATGCACAGAACAAGCCGTTTCCCTACAAGATGATC
TTTCCGTACGATGCCCAGAGCAGTTGGATCCGATATGTGATGACCTACATCTTCACCT
CCTACGCGGGAATCTGTGTGGTCACCACCTTGTTTGCAGAGGACACCATTCTTGGCTT
CTTCATAACCTACACTTGTGGCCAATTTCATTTGCTACACCAACGAATCGCAGGTTTA
TTTGCGGGTTCCAATGCGGAATTGGCCGAGAGCATTCAGCTGGAGCGACTCAAACGTA
TTGTGGAAAAACACAACAATATTATCAGCGCAAATTCTGTA

DOR44

MKSTFKEERIKDDSKRRDLFVFVRQTMCIAAMYPFGYYVNGSGVLAVLVRFCDLTYEL
FNYFVSVHIAGLYICTIYINYGQGDLDFFVNCLIQTIIYLWTIAMKLYFRRFRPGLLN
TILSNINDEYETRSAVGFSFVTMAGSYRMSKLWIKTYVYCCYIGTIFWLALPIAYRDR
SLPLACWYPFDYTQPGVYEVVFLLQAMGQIQVAASFASSSGLHMVLCVLISGQYDVLF
CSLKNVLASSYVLMGANMTELNQLQAEQSAADVEPGQYAYSVEEETPLQELLKVGSSM
DFSSAFRLSFVRCIQHHRYIVAALKKIESFYSPIWFVKIGEVTFLMCLVAFVSTKSTA
ANSFMRMVSLGQYLLLVLYELFIICYFADIVFQNSQRCGEALWRSPWQRHLKDVRSDY
MFFMLNSRRQFQLTAGKISNLNVDRFRGVGILT

DOR44nt

ATGAAGAGCACATTCAAGGAAGAAAGGATTAAGGACGACTCCAAGCGTCGCGACCTGT
TTGTATTCGTGAGGCAAACCATGTGTATAGCGGCCATGTATCCCTTCGGTTACTACGT
GAATGGATCTGGAGTCCTGGCCGTTCTGGTGCGATTCTGTGACTTGACCTACGAGCTC

TTTAACTACTTCGTTTCGGTACACATAGCTGGCCTGTACATCTGCACCATCTACATCA
ACTATGGGCAAGGCGATTTGGACTTCTTCGTGAACTGTTTGATACAAACCATTATTTA
TCTGTGGACAATAGCGATGAAACTCTACTTTCGGAGGTTCAGACCTGGTTTGTTGAAT
ACCATTCTGTCCAACATCAATGATGAGTACGAGACACGTTCGGCTGTGGGATTCAGTT
TCGTCACAATGGCGGGATCCTATCGGATGTCCAAGCTATGGATCAAAACCTATGTGTA
TTGCTGCTACATAGGCACCATTTTCTGGCTGGCTCTTCCCATTGCCTACCGGGATAGG
AGTCTTCCTCTTGCCTGCTGGTATCCCTTTGACTATACACAACCCGGTGTCTATGAGG
TAGTGTTCCTTCTCCAGGCGATGGGACAGATCCAAGTGGCCGCATCCTTTGCCTCCTC
CAGTGGCCTGCATATGGTGCTTTGTGTGCTGATATCAGGGCAGTACGATGTCCTCTTT
TGCAGTCTCAAGAATGTATTAGCCAGCAGCTATGTCCTTATGGGAGCCAATATGACGG
AACTGAATCAATTGCAGGCTGAGCAATCTGCGGCCGATGTCGAGCCAGGTCAGTATGC
TTACTCCGTGGAGGAGGAGACACCTTTGCAAGAACTTCTAAAAGTTGGGAGCTCAATG
GACTTCTCCTCCGCATTCAGGCTGTCTTTTGTGCGGTGCATTCAGCACCATCGATACA
TAGTGGCGGCACTGAAGAAAATTGAGAGTTTCTACAGTCCCATATGGTTCGTGAAGAT
TGGCGAAGTCACCTTTCTTATGTGCCTGGTAGCCTTCGTCTCCACGAAGAGCACCGCG
GCCAACTCATTCATGCGAATGGTCTCCTTGGGCCAGTACCTGCTCTTAGTTCTCTACG
AGCTGTTCATCATCTGCTACTTCGCGGACATCGTTTTTCAGAACAGCCAGCGGTGCGG
TGAAGCCCTCTGGCGAAGTCCTTGGCAGCGACATTTGAAGGATGTTCGCAGTGATTAC
ATGTTCTTTATGCTGAATTCCCGCAGGCAGTTCCAACTTACGGCCGGAAAAATAAGCA
ATCTAAACGTGGATCGTTTCAGAGGGGTGGGTATCCTTACT

DOR46

MAEVRVDSLEFFKSHWTAWRYLGVAHFRVENWKNLYVFYSIVSNLLVTLCYPVHLGIS
LFRNRTITEDILNLTTFATCTACSVKCLLYAYNIKDVLEMERLLRLLDERVVGPEQRS
IYGQVRVQLRNVLYVFIGIYMPCALFAELSFLFKEERGLMYPAWFPFDWLHSTRNYYI
ANAYQIVGISFQLLQNYVSDCFPAVVLCLISSHIKMLYNRFEEVGLDPARDAEKDLEA
CITDHKHILELFRRIEAFISLPMLIQFTVTALNVCIGLAALVFFVSEPMARMYFIFYS
LAMPLQIFPSCFFGTDNEYWFGRLHYAAFSCNWHTQNRSFKRKMMLFVEQSLKKSTAV
AGGMMRIHLDTFFSTLKGAYSLFTIIIRMRK

DOR46nt

ATGGCAGAGGTCAGAGTGGACAGTCTGGAGTTTTTCAAGAGCCATTGGACCGCCTGGC
GGTACTTGGGAGTGGCTCATTTTCGGGTCGAGAACTGGAAGAACCTTTACGTGTTTTA
CAGCATTGTGTCGAATCTTCTCGTGACCCTGTGCTACCCCGTTCACCTGGGAATATCC
CTCTTTCGCAACCGCACCATCACCGAGGACATCCTCAACCTGACCACCTTTGCGACCT
GCACAGCCTGTTCGGTGAAGTGCCTGCTCTACGCCTACAACATCAAGGATGTGCTGGA
GATGGAGCGGCTGTTGAGGCTTTTGGATGAACGCGTCGTGGGTCCGGAGCAACGCAGC
ATCTACGGACAAGTGAGGGTCCAGCTGCGAAATGTGCTATACGTGTTCATCGGCATCT

ACATGCCGTGTGCCCTGTTCGCCGAGCTATCCTTTCTGTTCAAGGAGGAGCGCGGTCT
GATGTATCCCGCCTGGTTTCCCTTCGACTGGCTGCACTCCACCAGGAACTATTACATA
GCGAACGCCTATCAGATAGTGGGCATCTCGTTTCAGCTGCTGCAAAACTATGTTAGCG
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CAGATTCGAGGAGGTGGGCCTGGATCCAGCCAGAGATGCGGAGAAGGACCTGGAGGCC
TGCATCACCGATCACAAGCATATTCTAGAGTGGGCAGGCGGCTCATTGGTTCGTGTTC
TATTCACTTTCCAACTTTTTTCCAGACTATTCCGACGCATCGAGGCCTTCATTTCCCT
GCCCATGCTAATTCAGTTCACAGTGACCGCCTTGAATGTGTGCATCGGTTTAGCAGCC
CTGGTGTTTTTCGTCAGCGAGCCCATGGCACGGATGTACTTCATCTTCTACTCCCTGG
CCATGCCGCTGCAGATCTTTCCGTCCTGCTTTTTCGGCACCGACAACGAGTACTGGTT
CGGACGCCTCCACTACGCGGCCTTCAGTTGCAATTGGCACACACAGAACAGGAGCTTT
AAGCGGAAAATGATGCTGTTCGTTGAGCAATCGTTGAAGAAGAGCACCGCTGTGGCTG
GCGGAATGATGCGTATCCACCTGGACACGTTCTTTTCCACCCTAAAGGGGGCCTACTC
CCTCTTTACCATCATTATTCGGATGAGAAAG

DOR48

MERHYFMVPKFALSLIGFYPEQKRTVLVKLWSFFNFFILTYGCYAEAYYGIHYIPINI
ATALDALCPVASSILSLVKMVAIWWYQDELRSLIERRFYTLATQLTFLLLCCGFCTST
SYSVRHLIDNILRRTHGKDWIYETPFKMMFPDLLLRLPLYPITYILVHWHGYITVVCF
VGADGFFLGFCLYFTVLLLCLQDDVCDLLEVENIEKSPSEAEEARIVREMEKLVDRHN
EVAELTERLSGVMVEITLAHFVTSSLIIGTSVVDILLFSGLGIIVYVVYTCAVGVEIF
LYCLGGSHIMEACSNLARSTFSSHWYGHSVRVQKMTLLMVARAQRVLTIKIPFFSPSL
ETLTSILRFTGSLIALAKSVI

DOR48nt

ATGGAGCGCCATTATTTCATGGTGCCAAAGTTTGCATTATCGCTGATTGGTTTTTATC
CCGAACAGAAGCGAACGGTTTTGGTGAAACTTTGGAGTTTCTTCAACTTTTTCATCCT
CACCTACGGCTGTTATGCAGAGGCTTACTATGGCATACACTATATACCGATTAACATA
GCCACTGCATTGGATGCCCTTTGTCCTGTGGCCTCCAGCATTTTGTCGCTGGTGAAAA
TGGTCGCCATTTGGTGGTATCAAGATGAATTAAGGAGTTTGATAGAGCGGGTAAGATT
TTTAACAGAGCAACAGAAGTCCAAGAGGAAACTGGGCTATAAGAAGAGGTTCTATACA
CTGGCAACGCAACTAACATTCCTGCTACTATGCTGTGGATTTTGCACCAGTACTTCCT
ATTCCGTCAGACATTTGATTGATAATATCCTGAGACGCACCCATGGCAAGGACTGGAT
CTACGAGACTCCGTTCAAGATGATGTAAGGAAAGGGAAGAATGGTTTATATATACTTT
TGGAACGAAATAATGATGTGATCTAAACAAGATGCACTTTTTTTAGGTTCCCCGATC
TTCTCCTGCGTTTGCCACTCTATCCCATCACCTATATACTCGTGCATTGGCATGGCTA
CATTACTGTGGTTTGTTTTGTCGGCGCGGATGGTTTCTTCCTGGGGTTCTGTTTGTAC
TTCACTGTTTTGCTGCTCTGTCTGCAGGACGATGTTTGTGATTTACTAGAGGTTGAAA

ACATCGAGAAGAGTCCCTCCGAAGCGGAGGAAGCTCGCATAGTTCGGGAAATGGAAAA
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GTGGAAATAACACTGGCCCACTTTGTTACTTCGAGTTTGATAATCGGAACCAGCGTGG
TGGATATTTTATTAGTGGGTATTTACATTTGATTAGATCCTTTCGATATATGTTCTTA
AATTCTAGTTTTCCGGCCTGGGAATCATTGTGTATGTGGTCTACACTTGTGCCGTAGG
TGTGGAAATATTTCTATACTGTTTAGGAGGATCTCATATTATGGAAGCGGTATATTCA
TAAGAAACTACTATAAAGTTACTTTTAAATTCATTGCATTTCTTAGTGTTCCAATCTA
GCGCGCTCCACATTTTCCAGCCACTGGTATGGCCACAGTGTTCGGGTCCAAAAGATGA
CCCTTTTGATGGTAGCTCGTGCTCAACGAGTTCTCACAATTAAAATTCCTTTCTTTTC
CCCATCATTAGAGACTCTAACTTCGGTAAGCTTATGCGAAAATGTTATGGTACACACA
AGTCTACATTTCTATGAGGTCTTGTAGATTTTGCGCTTCACTGGATCTCTGATTGCCC
TGGCAAAGTCGGTTATA

DOR53

MLSKFFPHIKEKPLSERVKSRDAFIYLDRVMWSFGWTEPENKRWILPYKLWLAFVNIV
MLILLPISISIEYLHRFKTFSAGEFLSSLEIGVNMYGSSFKCAFTLIGFKKRQEAKVL
LDQLDKRCLSDKERSTVHRYVAMGNFFDILYHIFYSTFVVMNFPYFLLERRHAWRMYF
PYIDSDEQFYISSIAECFLMTEAIYMDLCTDVCPLISMLMARCHISLLKQRLRNLRSK
PGRTEDEYLEELTECIRDHRLLLDYVDALRPVFSGTIFVQFLLIGTVLGLSMINLMFF
STFWTGVATCLFMFDVSMETFPFCYLCNMIIDDCQEMSNCLFQSDWTSADRRYKSTLV
YFLHNLQQPITLTAGGVFPISMQTNLAMVKLAFSVVTVIKQFNLAERFQ

DOR53nt

TCAAACAAAGCCACGGACAAGATGTTAAGCAAGTTTTTTCCCCACATAAAAGAAAAGC
CATTGAGCGAGCGGGTTAAGTCCCGAGATGCCTTCATTTACTTGGATCGGGTGATGTG
GTCCTTTGGCTGGACAGAGCCTGAAAACAAAAGGTGGATCCTTCCTTATAAACTGTGG
TTAGCGTTCGTGAACATAGTAATGCTCATCCTTCTGCCGATCTCGATAAGCATCGAGT
ACCTCCACCGATTTAAAACCTTCTCGGCGGGGGAGTTCCTTAGTTCCCTCGAGATTGG
AGTCAACATGTACGGAAGCTCTTTTAAGTGCGCCTTCACCTTGATTGGATTCAAGAAA
AGACAGGAAGCTAAGGTTTTACTGGATCAGCTGGACAAGAGATGCCTTAGCGATAAGG
AGAGGTCCACTGTTCATCGCTATGTCGCCATGGGAAACTTTTTCGATATTTTGTATCA
CATTTTTTACTCCACCTTCGTGGTAATGAACTTCCCGTATTTTCTGCTTGAGAGACGC
CATGCTTGGCGCATGTACTTTCCATATATCGATTCCGACGAACAGTTTTACATCTCCA
GCATCGCCGAGTGTTTTCTGATGACGGAGGCCATCTACATGGATCTCTGTACGGACGT
GTGTCCCTTGATCTCCATGCTTATGGCTCGATGCCACATCAGCCTCCTGAAACAGCGA
CTGAGAAATCTCCGATCGAAGCCAGGAAGGACCGAAGATGAGTACTTGGAGGAGCTCA
CCGAGTGCATTCGGGATCATCGATTGCTATTGGACTATGTTGACGCATTGCGACCCGT
CTTTTCGGGAACCATTTTTGTGCAGTTCCTCCTGATCGGTACTGTACTGGGTCTCTCA

ATGATAAATCTAATGTTCTTCTCGACATTTTGGACTGGTGTCGCCACTTGCCTTTTTA
TGTTCGACGTGTCCATGGAGACGTTCCCCTTTTGCTATTTGTGCAACATGATTATCGA
TGACTGCCAGGAAATGTCCAATTGCCTCTTTCAATCGGACTGGACCTCTGCCGATCGT
CGCTACAAATCCACTTTGGTATACTTTCTTCACAATCTTCAGCAACCCATTACTCTCA
CGGCTGGTGGAGTGTTTCCTATTTCCATGCAAACAAATTTGGCTATGGTGAAGCTGGC
ATTTTCTGTGGTTACGGTAATTAAGCAATTTAACTTGGCCGAAAGGTTTCAATAAGTT
GAGAGGGACGAGCTCTGCTACTATTATATTATATATTATATTATATTATATATATATT
ATTTTATATTATATATTGCTGTACCCTAATAAATATTTAGTAATAAAAAAAAAAAAAA
AAAA

DOR56

MDPVEMPIFGSTLKLMKFWSYLFVHNWRRYVAMTPYIIINCTQYVDIYLSTESLDFII
RNVYLAVLFTNTVVRGVLLCVQRFSYERFINILKSFYIELLVSTERLSQKCILHKWAV
LPYGMYLPTIDEYKYASPYYEIFFVIQAIMAPMGCCMYIPYTNMVVTFTLFAILMCRV
LQHKLRSLEKLKNEQVRGEIAQTIAQTVIVIAYMVMIFANSVVLYYVANELYFQSFDI
AIAAYESNWMDFDVDTQKTLKFLIMRSQKPLASLVGGTYPMNLKMLQSLLNAIYSFFT
LLRRVYG

DOR56nt

ATGGATCCGGTGGAGATGCCCATTTTTGGTAGCACTCTGAAGCTAATGAAGTTCTGGT
CATATCTGTTTGTTCACAACTGGCGCCGCTATGTCGCAATGACTCCGTACATCATTAT
CAACTGTACTCAGTATGTGGATATATATCTGAGCACCGAATCCTTGGACTTTATCATC
AGAAATGTATACCTGGCTGTATTGTTTACCAACACGGTGGTCAGAGGTGTATTGTTAT
GCGTACAGCGGTTTAGCTACGAGCGTTTCATTAATATTTTGAAAAGCTTTTACATTGA
GTTGTTGGTGAGTACCGAAAGATTATCTCAAAAATGCATATTGCATAAATGGGCAGTT
CTGCCATATGGCATGTATTTGCCCACTATTGATGAATACAAATACGCATCACCTTACT
ACGAGATTTTCTTTGTGATTCAAGCCATTATGGCTCCAATGGGGTGTTGCATGTACAT
ACCATACACAAACATGGTAGTGACATTTACCCTTTTCGCCATTCTCATGTGTCGAGTG
TTGCAACATAAGTTGAGAAGCCTAGAAAAGCTGAAAAATGAACAAGTACGTGGTGAAA
TCGCTCAAACAATTGCTCAGACCGTCATAGTCATCGCATACATGGTAATGATATTTGC
CAACAGTGTAGTCCTTTACTACGTGGCCAATGAGCTATACTTTCAAAGCTTTGATATT
GCCATTGCTGCCTATGAGAGCAATTGGATGGACTTTGATGTGGACACACAAAAGACTT
TGAAGTTCCTCATCATGCGCTCGCAAAAGCCCTTGGCGAGTCTGGTGGGTGGCACATA
TCCCATGAACTTGAAAATGCTTCAGTCACTACTAAATGCCATTTACTCCTTCTTCACC
CTTCTGCGTCGCGTTTACGGC

DOR58

MDASYFAVQRRALEIVGFDPSTPQLSLKHPIWAGILILSLISHNWPMVVYALQDLSDL
TRLTDNFAVFMQGSQSTFKFLVMMAKRRRIGSLIHRLHKLNQAASATPNHLEKIEREN
QLDRYVARSFRNAAYGVICASAIAPMLLGLWGYVETGVFTPTTPMEFNFWLDERKPHF
YWPIYVWGVLGVAAAAWLAIATDTLFSWLTHNVVIQFQLLELVLEEKDLNGGDSRLTG
FVSRHRIALDLAKELSSIFGEIVFVKYMLSYLQLCMLAFRFSRSGWSAQVPFRATFLV
AIIIQLSSYCYGGEYIKQQSLAIAQAVYGQINWPEMTPKKRRLWQMVIMRAQRPAKIF
GFMFVVDLPLLLWVIRTAGSFLAMLRTFER

DOR58nt

ATGGACGCCAGCTACTTTGCCGTCCAGAGAAGAGCTCTGGAAATAGTTGGATTCGATC
CCAGTACTCCGCAACTGAGTCTGAAACATCCCATCTGGGCCGGGATTCTCATCCTGTC
CTTGATCTCTCACAACTGGCCCATGGTAGTCTATGCCCTGCAGGATCTCTCCGACTTG
ACCCGTCTGACGGACAACTTTGCGGTGTTTATGCAAGGATCACAGAGCACCTTCAAGT
TCCTGGTCATGATGGCGAAACGAAGGCGCATTGGATCGTTGATTCACCGTTTGCATAA
GCTAAACCAGGCGGCCAGTGCCACGCCCAATCACCTGGAGAAGATCGAGAGGGAAAAC
CAACTGGATAGGTATGTCGCCAGGTCCTTTAGAAATGCCGCCTACGGAGTGATTTGTG
CCTCGGCCATAGCGCCCATGTTGCTTGGCCTGTGGGGATATGTGGAGACGGGTGTATT
TACCCCCACCACACCCATGGAGTTCAACTTCTGGCTGGACGAGCGAAAGCCTCACTTT
TATTGGCCCATCTACGTTTGGGGCGTACTGGGCGTGGCAGCTGCCGCCTGGTTGGCCA
TTGCAACGGACACCCTGTTCTCCTGGCTGACTCACAATGTGGTGATTCAGTTCCAACT
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TTTGTTAGTCGTCATCGTATAGCTCTGGATTTGGCCAAGGAACTAAGTTCGATTTTCG
GGGAGATCGTCTTTGTGAAATACATGCTCAGTTACCTGCAACTCTGCATGTTGGCCTT
TCGCTTCAGCCGCAGTGGCTGGAGTGCCCAGGTGCCATTTAGAGCCACCTTCCTAGTG
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GAAAAGAAGACTCTGGCAAATGGTGATCATGAGGGCGCAGCGACCGGCTAAGATTTTT
GGATTCATGTTCGTTGTGGACTTGCCACTGCTGCTTTGGGTCATCAGAACTGCGGGCT
CATTTCTGGCCATGCTTAGGACTTTCGAGCGT

DOR59

MHEADNREMELLVATQAYTRTITLLIWIPSVIAGLMAYSDCIYRSLFLPKSVFNVPAV
RRGEEHPILLFQLFPFGELCDNFVVGYLGPWYALGLGITAIPLWHTFITCLMKYVNLK
LQILNKRVEEMDITRLNSKLVIGRLTASELTFWQMQLFKEFVKEQLRIRKFVQELQYL
ICVPVMADFIIFSVLICFLFFALTVGHDELSLAYFSCGWYNFEMPLQKMLVFMMMHAQ
RPMKMRALLVDLNLRTFIDIGRGAYSYFNLLRSSHLY

DOR59nt

ATGCACGAAGCAGATAATCGGGAGATGGAACTTTTGGTCGCCACTCAGGCTTATACAC
GAACCATTACCCTGTTGATCTGGATACCATCGGTTATTGCTGGCCTAATGGCCTATTC
AGACTGCATCTACAGGAGTCTGTTTCTGCCGAAATCGGTTTTCAATGTGCCAGCTGTG
CGACGTGGTGAGGAGCATCCCATTCTGCTATTTCAGCTGTTTCCCTTCGGAGAACTTT
GCGATAACTTCGTTGTTGGATACTTGGGACCTTGGTATGCTCTGGGCCTGGGAATCAC
GGCTATCCCATTGTGGCACACCTTTATCACTTGCCTCATGAAGTACGTAAATCTCAAG
CTGCAAATACTCAACAAGCGAGTGGAGGAGATGGATATTACCCGACTTAATTCCAAAT
TGGTAATTGGTCGCCTAACTGCCAGTGAGTTAACCTTCTGGCAAATGCAACTCTTCAA
GGAATTTGTAAAGGAACAGCTGAGGATTCGAAAATTTGTCCAGGAACTACAGTATCTG
ATTTGCGTGCCTGTGATGGCAGATTTCATTATCTTCTCGGTTCTCATTTGCTTTCTCT
TTTTTGCCTTGACAGTTGGCCACGATGAACTGAGCCTTGCTTACTTTTCTTGCGGATG
GTACAACTTCGAAATGCCTTTGCAGAAAATGCTGGTTTTTATGATGATGCATGCCCAA
AGGCCGATGAAGATGCGCGCCCTGCTGGTCGATTTGAATCTGAGGACCTTCATAGACA
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DOR61

MGHKDDMDSTDSTALSLKHISSLIFVISAQYPLISYVAYNRNDMEKVTACLSVVFTNM
LTVIKISTFLANRKDFWEMIHRFRKMHEQCKYREGLDYVAEANKLASFLGRAYCVSCG
LTGLYFMLGPIVKIGVCRWHGTTCDKELPMPMKFPFNDLESPGYEVCFLYTVLVTVVV
VAYASAVDGLFISFAINLRAHFQTLQRQIENWEFPSSEPDTQIRLKSIVEYHVLLLSL
SRKLRSIYTPTVMGQFVITSLQVGVIIYQLVTNMDSVMDLLLYASFFGSIMLQLFIYC
YGGEIIKAESLQVDTAVRLSNWHLASPKTRTSLSLIILQSQKEVLIRAGFFVASLANF
PYRLITLIKSIDSIC

DOR61nt

information on nucleotide sequence is in progress

DOR62

MEKQEDFKLNTHSAVYYHWRVWELTGLMRPPGVSSLLYVVYSITVNLVVTVLFPLSLL
ARLLFTTNMAGLCENLTITITDIVANLKFANVYMVRKQLHEIRSLLRLMDARARLVGD
PEEISALRKEVNIAQGTFRTFASIFVFGTTLSCVRVVVRPDRELLYPAWFGVDWMHST
RNYVLINIYQLFGLIVQAIQNCASDSYPPAFLCLLTGHMRALELRVRRIGCRTEKSNK
GQTYEAWREEVYQELIECIRDLARVHRLREIIQRVLSVPCMAQFVCSAAVQCTVAMHF
LYVADDHDHTAMIISIVFFSAVTLEVFVICYFGDRMRTQSEALCDAFYDCNWIEQLPK
FKRELLFTLARTQRPSLIYAGNYIALSLETFEQVMRFTYSVFTLLLRAK

DOR62nt

ATGGAGAAGCAAGAGGATTTCAAACTGAACACCCACAGTGCTGTGTACTACCACTGGC
GCGTTTGGGAGCTCACTGGCCTGATGCGTCCTCCGGGCGTTTCAAGCCTGCTTTACGT
GGTATACTCCATTACGGTCAACTTGGTGGTCACCGTGCTGTTTCCCTTGAGCTTGCTG
GCCAGGCTGCTGTTCACCACCAACATGGCCGGATTGTGCGAGAACCTGACCATAACTA
TTACCGATATTGTGGCCAATTTGAAGTTTGCGAATGTGTACATGGTGAGGAAGCAGCT
CCATGAGATTCGCTCTCTCCTAAGGCTCATGGACGCTAGAGCCCGGCTGGTGGGCGAT
CCCGAGGAGATTTCTGCCTTGAGGAAGGAAGTGAATATCGCACAGGGCACTTTCCGCA
CCTTTGCCAGTATTTTCGTATTTGGCACTACTTTGAGTTGCGTCCGCGTGGTCGTTCG
CCCGGATCGAGAGCTCCTGTATCCGGCCTGGTTCGGCGTTGACTGGATGCACTCCACC
AGAAACTATGTGCTCATCAATATCTACCAGCTCTTCGGCTTGATAGTGCAGGCTATAC
AGAACTGCGCTAGTGACTCCTATCCGCCTGCGTTTCTCTGCCTGCTCACGGGTCATAT
GCGTGCTTTGGAGCTGAGGGTGCGGCGGATTGGCTGCAGGACGGAAAAGTCCAATAAA
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GCGATCTGGCGCGGGTCCATCGGCTGAGGGAGATCATTCAGCGGGTCCTTTCAGTGCC
CTGCATGGCCCAGTTCGTCTGCTCCGCCGCCGTCCAGTGTACCGTCGCCATGCACTTC
CTGTACGTAGCGGATGACCACGACCACACCGCCATGATCATCTCGATTGTATTTTTCT
CGGCCGTCACCTTGGAGGTGTTTGTAATCTGCTATTTTGGGGACAGGATGCGGACACA
GAGCGAGGCGCTGTGCGATGCCTTCTACGATTGCAACTGGATAGAACAGCTGCCCAAG
TTCAAGCGCGAACTGCTCTTCACCCTGGCCAGGACGCAGCGGCCTTCTCTTATTTACG
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CTCTGTTTTCACACTCTTGCTGAGGGCCAAGTAAGAACTTTATAATCTCTTTTTGGGG
AGAAAAATTTTAAAGCACAATAGCAGAAAAATATATCAGATAATATAACAAAAAAAAA
AAAAAAAAA

DOR64

MKLSETLKIDYFRVQLNAWRICGALDLSEGRYWSWSMLLCILVYLPTPMLLRGVYSFE
DPVENNFSLSLTVTSLSNLMKFCMYVAQLTKMVEVQSLIGQLDARVSGESQSERHRNM
TEHLLRMSKLFQITYAVVFIIAAVPFVFETELSLPMPMWFPFDWKNSMVAYIGALVFQ
EIGYVFQIMQCFAADSFPPLVLYLISEQCQLLILRISEIGYGYKTLEENEQDLVNCIR
DQNALYRLLDVTKSLVSYPMMVQFMVIGINIAITLFVLIFYVETLYDRIYYLCFLLGI
TVQTYPLCYYGTMVQESFAELHYAVFCSNWVDQSASYRGHMLILAERTKRMQLLLAGN
LVPIHLSTYVACWKGAYSFFTLMADRDGLGS

DOR64nt

GGCACGAGCCAAGAATTCAAAATGAAACTCAGCGAAACCCTAAAAATCGACTATTTTC
GAGTCCAGTTGAATGCCTGGCGAATTTGTGGTGCCTTGGATCTCAGCGAGGGTAGGTA

CTGGAGTTGGTCGATGCTATTGTGCATCTTGGTGTACCTGCCGACACCCATGCTACTG
AGAGGAGTATACAGTTTCGAGGATCCGGTGGAAAATAATTTCAGCTTGAGCCTGACGG
TCACATCGCTGTCCAATCTCATGAAGTTCTGCATGTACGTGGCCCAACTAACAAAGAT
GGTCGAGGTCCAGAGTCTTATTGGTCAGCTGGATGCCCGGGTTTCTGGCGAGAGCCAG
TCTGAGCGTCATAGAAATATGACCGAGCACCTGCTAAGGATGTCCAAGCTGTTCCAGA
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CAGCTGACTCGTTTCCCCCGCTCGTACTGTACCTGATCTCCGAGCAATGTCAATTGCT
GATCCTGAGAATCTCTGAAATCGGATATGGTTACAAGACTCTGGAGGAGAACGAACAG
GATCTGGTCAACTGCATCAGGGATCAAAACGCGCTGTATAGATTACTCGATGTGACCA
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CATCACCCTATTTGTCCTGATATTTTACGTGGAGACCTTGTACGATCGCATCTATTAT
CTTTGCTTTCTCTTGGGCATCACCGTGCAGACATATCCATTGTGCTACTATGGAACCA
TGGTGCAGGAGAGTTTTGCTGAGCTTCACTATGCGGTATTCTGCAGCAACTGGGTGGA
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GGAAGGGAGCCTACTCCTTCTTCACCCTGATGGCCGATCGAGATGGCCTGGGTTCTTA
GTAGCCCAGTCATTTCACTCACATTCTACATCAAGTAGTACTACCACTGAACACGAAC
ACGAATATTTCAAAAGTAAACACATAATATTCACAATAGTGTATCACTTTAATAAAAT
TTTTGGTTACCATGAAAAAAAAAAAAAAAAAAA

DOR67

MLSQFFPHIKEKPLSERVKSRDAFVYLDRVMWSFGWTVPENKRWDLHYKLWSTFVTLV
IFILLPISVSVEYIQRFKTFSAGEFLSSIQIGVNMYGSSFKSYLTMMGYKKRQEAKMS
LDELDKRCVCDEERTIVHRHVALGNFCYIFYHIAYTSFLISNFLSFIMKRIHAWRMYF
PYVDPEKQFYISSIAEVILRGWAVFMDLCTDVCPLISMVIARCHITLLKQRLRNLRSE
PGRTEDEYLKELADCVRDHRLILDYVDALRSVFSGTIFVQFLLIGIVLGLSMINIMFF
STLSTGVAVVLFMSCVSMQTFPFCYLCNMIMDDCQEMADSLFQSDWTSADRRYKSTLV
YFLHNLQQPIILTAGGVFPISMQTNLNMVKLAFTVVTIVKQFNLAEKFQ

DOR67nt

GGCACGAGGAAATGTTAAGCCAGTTCTTTCCCCACATTAAAGAAAAGCCATTGAGCGA
GCGGGTTAAGTCCCGAGATGCCTTCGTTTACTTAGATCGGGTGATGTGGTCCTTTGGC
TGGACAGTGCCTGAAAACAAAAGGTGGGATCTACATTACAAACTGTGGTCAACTTTCG
TGACATTGGTGATATTTATCCTTCTGCCGATATCGGTAAGCGTTGAGTATATTCAGCG
GTTCAAGACCTTCTCGGCGGGTGAGTTTCTTAGCTCAATCCAGATTGGCGTTAACATG
TACGGAAGCAGCTTTAAAAGTTATTTGACCATGATGGGATATAAGAAGAGACAGGAGG

CTAAGATGTCACTGGATGAGCTGGACAAGAGATGCGTTTGTGATGAGGAGAGGACCAT
TGTACATCGACATGTCGCCCTGGGAAACTTTTGCTATATTTTCTATCACATTGCGTAC
ACTAGCTTTTTGATTTCAAACTTTTTGTCATTTATAATGAAGAGAATCCATGCCTGGC
GCATGTACTTTCCCTACGTCGACCCCGAAAAGCAATTTTACATCTCTAGCATCGCCGA
AGTCATTCTTAGGGGGTGGGCCGTCTTCATGGATCTCTGCACGGATGTGTGTCCTTTG
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TACGATCGGAACCAGGAAGGACGGAAGATGAGTACTTGAAGGAGCTCGCCGACTGCGT
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ATCTATGCAGACGTTCCCCTTTTGCTATTTGTGTAACATGATTATGGATGACTGCCAA
GAGATGGCCGACTCCCTTTTTCAATCGGACTGGACATCTGCCGATCGTCGCTACAAAT
CCACTTTGGTATACTTTCTTCACAATCTTCAGCAGCCCATTATTCTTACGGCTGGTGG
AGTCTTTCCTATTTCCATGCAAACAAATTTAAATATGGTGAAGCTGGCCTTTACTGTG
GTTACAATAGTGAAACAATTTAACTTGGCAGAAAAGTTTCAATAAGTTAAGATATGCA
AGCTCTGCTATTATAAACCTACACTCGAGAAAATATTTCTTCACATTAATAAACCTTC
AGTACTTACTGCTTGTGGCGCCCCCGGAAAAAAAAAAAAAAAAAA

DOR68

MSKLIEVFLGNLWTQRFTFARMGLDLQPDKKGNVLRSPLLYCIMCLTTSFELCTVCAF
MVQNRNQIVLCSEALMHGLQMVSSLLKMAIFLAKSHDLVDLIQQIQSPFTEEDLVGTE
WRSQNQRGQLMAAIYFMMCAGTSVSFLLMPVALTMLKYHSTGEFAPVSSFRVLLPYDV
TQPHVYAMDCCLMVFVLSFFCCSTTGVDTLYGWCALGVSLQYRRLGQQLKRIPSCFNP
SRSDFGLSGIFVEHARLLKIVQHFNYSFMEIAFVEVVIICGLYCSVICQYIMPHTNQN
FAFLGFFSLVVTTQLCIYLFGAEQVRLEAERFSRLLYEVIPWQNLPPKHRKLFLFPIE
RAQRETVLGAYFFELGRPLLVWVSIFLFIVLLF

DOR68nt

ATGTCAAAGCTAATCGAGGTGTTTCTGGGTAATCTGTGGACCCAGCGTTTTACCTTCG
CCCGAATGGGTTTGGATTTGCAGCCCGATAAAAAGGGCAATGTTTTGCGATCTCCGCT
TCTTTATTGTATTATGTGTCTGACAACAAGCTTTGAGCTCTGCACCGTGTGCGCCTTT
ATGGTCCAAAATCGCAACCAAATCGTGCTTTGTTCCGAGGCCCTGATGCACGGACTAC
AGATGGTCTCCTCGCTACTGAAGATGGCTATATTCTTGGCCAAATCTCACGACCTGGT
GGACCTAATTCAACAGATTCAGTCGCCTTTTACAGAGGAGGATCTTGTAGGTACAGAG
TGGAGATCCCAAAATCAAAGGGGACAACTAATGGCTGCCATTTACTTTATGATGTGTG
CCGGTACGAGTGTGTCATTTCTGTTGATGCCAGTGGCTTTGACCATGCTTAAGTACCA
TTCCACTGGGGAATTCGCGCCTGTCAGCTCGTTCCGGGTTCTGCTTCCATACGATGTG
ACACAACCGCATGTTTATGCCATGGACTGCTGCTTGATGGTATTTGTGTTAAGTTTTT

TTTGCTGCTCCACCACCGGAGTGGATACCTTATATGGATGGTGTGCTTTAGGCGTGAG
TTTACAATACCGTCGCCTCGGTCAACAACTTAAAAGGATACCCTCCTGTTTCAATCCA
TCTCGGTCTGACTTTGGATTAAGTGGGATTTTTGTGGAGCATGCTCGTCTGCTTAAAA
TAGTCCAACATTTTAATTATAGTTTTATGGAGATCGCATTTGTGGAGGTTGTTATAAT
CTGTGGACTCTATTGCTCAGTAATTTGTCAGTATATAATGCCACACACCAACCAAAAC
TTCGCCTTTCTGGGTTTCTTTTCATTGGTAGTTACCACACAGCTGTGCATCTATCTTT
TCGGTGCCGAACAGGTCCGTTTGGAGGCTGAGCGATTTTCCCGGCTGCTATACGAAGT
AATTCCTTGGCAAAACCTTCCTCCTAAACACCGGAAACTTTTCCTTTTTCCAATTGAG
CGCGCCCAACGAGAAACTGTTCTCGGTGCTTATTTCTTCGAACTAGGCAGACCTCTTC
TTGTTTGGGTAAGCATATTCCTTTTTATTGTATTATTATTT

DOR71

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HVHCHARRFTRCLYISFGMIYALFLFGVFVQVISGNWELLYPAYFPFDLESNRFLGAV
ALGYQVFSMLVEGFQGLGNDTYTPLTLCLLAGHVHLWSIRMGQLGYFDDETVVNHQRL
LDYIEQHKLLVRFHNLVSRTISEVQLVQLGGCGATLCIIVSYMLFFVGDTISLVYYLV
FFGVVCVQLFPSCYFASEVAEELERLPYAIFSSRWYDQSRDHRFDLLIFTQLTLGNRG
WIIKAGGLIELNLNAFFATLKMAYSLFAVVHRETGNPLQREH

DOR71nt

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GCCTTGGGCTATCAGGTATTCAGCATGTTAGTTGAAGGCTTCCAGGGGCTGGGCAACG
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ACGAATGGGTCAACTGGGATACTTCGATGACGAGACGGTGGTGAATCATCAGCGTTTG
CTGGATTACATTGAGCAGCATAAACTCTTGGTGCGGTTCCACAACCTGGTGAGCCGGA
CCATCAGCGAAGTGCAACTGGTGCAGCTGGGCGGATGTGGAGCCACTCTGTGCATCAT
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GCGGGATCATCGATTCGATTTGCTCATCTTTACACAATTAACACTGGGAAACCGGGGG
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TGAAGATGGCCTATTCCCTTTTTGCAGTTGTGGTGCGGGCAAAGGGTATA

DOR72

MDLKPRVIRSEDIYRTYWLYWHLLGLESNFFLNRLLDLVITIFVTIWYPIHLILGLFM
ERSLGDVCKGLPITAACFFASFKFICFRFKLSEIKEIEILFKELDQRALSREECEFFN
QNTRREANFIWKSFIVAYGLSNISAIASVLFGGGHKLLYPAWFPYDVQATELIFWLSV
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ESIEDHRKLMKIVELLRSTMNISQLGQFISSGVNISITLVNILFFADNNFAITYYGVY
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DOR72nt

ATGGACTTAAAACCGCGAGTCATTCGAAGTGAAGATATCTACAGAACCTATTGGTTAT
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DOR73

MDSRRKVRSENLYKTYWLYWRLLGVEGDYPFRRLVDFTITSFITILFPVHLILGMYKK
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PSRVARMLSKSYLVAAISAIITATVAGLFSTGRNLMYLGWFPYDFQATAAIYWISFSY
QAIGSSLLILENLANDSYPPITFCVVSGHVRLLIMRLSRIGHDVKLSSSENTRKLIEG
IQDHRKLMKIIRLLRSTLHLSQLGQFLSSGINISITLINILFFAENNFAMLYYAVFFA
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DOR73nt

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CCCCAGATTCAAGTCTTCAGGAGTCTGCATTTCACATCGGAATGCCTTTTCTGCAGCT
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CAATCGATCCTTGATAATTCTGATGCAACTAACACTGGTTCCAGTGAATATAAAAGCA
GGTGGTATTGTTGGCATCGATATGAGTGCATTTTTTGCCACAGTTCGGATGGCATATT
CCTTTTACACTTTAGCCTTGTCATTTCGAGTA

DOR77

MELMRVPVQFYRTIGEDIYAHRSTNPLKSLLFKIYLYAGFINFNLLVIGELVFFYNSI
QDFETIRLAIAVAPCIGFSLVADFKQAAMIRGKKTLIMLLDDLENMHPKTLAKQMEYK
LPDFEKTMKRVINIFTFLCLAYTTTFSFYPAIKASVKFNFLGYDTFDRNFGFLIWFPF
DATRNNLIYWIMYWDIAHGAYLAAFQVTESTVEVIIIYCIFLMTSMVQVFMVCYYGDT
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FNNLPKHSSSLQINANRYI

DOR77nt

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CAGGACTTTGAAACCATTCGATTGGCCATCGCGGTGGCTCCATGTATCGGATTTTCTC
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DOR78

MKFMKYAVFFYTSVGIEPYTIDSRSKKASLWSHLLFWANVINLSVIVFGEILYLGVAY
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DRYLRSCSRISITYALLYSVLIWTFNLFSIMQFLVYEKLLKIRVVGQTLPYLMYFPWN
WHENWTYYVLLFCQNFAGHTSASGQISTDLLLCAVATQVVMHFDYLARVVEKQVLDRD
WSENSRFLAKTVQYHQRILRLMDVLNDIFGIPLLLNFMVSTFVICFVGFQMTVGVPPD
IMIKLFLFLFSSLSQVYLICHYGQLIADAVRDFRSSSLSISAYKQNWQNADIRYRRAL
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DOR78nt

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TCCGATGGAAAGTTCATTGATGCCGTCACTGTACTGTCATATATCGGATTCGTAATCG
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ATATAACAAGGGCCACCATGACGGACGTAAGATACAATTTGAAATGTCAT

DOR81

MMETLRNSGLNLKNDFGIGRKIWRVFSFTYNMVILPVSFPINYVIHLAEFPPELLLQS
LQLCLNTWCFALKFFTLIVYTHRLELANKHFDELDKYCVKPAEKRKVRDMVATITRLY
LTFVVVYVLYATSTLLDGLLHHRVPYNTYYPFINWRVDRTQMYIQSFLEYFTVGYAIY
VATATDSYPVIYVAALRTHILLLKDRIIYLGDPSNEGSSDPSYMFKSLVDCIKAHRTM
LNFCDAIQPIISGTIFAQFIICGSILGIIMINMVLFADQSTRFGIVIYVMAVLLQTFP
LCFYCNAIVDDCKELAHALFHSAWWVQDKRYQRTVIQFLQKLQQPMTFTAMNIFNINL
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DOR81nt

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CCCAATCAACTATGTGATACATCTGGCGGAGTTCCCGCCGGAGCTGCTGCTGCAATCC
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GAAGCCGGCGGAGAAGCGCAAGGTTCGCGACATGGTGGCCACTATTACAAGACTGTAC
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CGCGAGCGGTATGAACCTGGACCAAAAGTTAAGCATTAAGGAA

DOR82

MACIPRYQWKGRPTERQFYASEQRIVFLLGTICQIFQITGVLIYWYCNGRLATETGTF
VAQLSEMCSSFCLTFVGFCNVYAISTNRNQIETLLEELHQIYPRYRKNHYRCQHYFDM
AMTIMRIEFLFYMILYVYYNSAPLWVLLWEHLHEEYDLSFKTQTNTWFPWKVHGSALG
FGMAVLSITVGSFVGVGFSIVTQNLICLLTFQLKLHYDGISSQLVSLDCRRPGAHKEL
SILIAHHSRILQLGDQVNDIMNFVFGSSLVGATIAICMSSVSIMLLDLASAFKYASGL
VAFVLYNFVICYMGTEVTLAVKIGSYMDGRRWIPKDSLLRSQRLQVLVAVGFFNICVL
SNRRPKIEILLRYYYHIMFYSFKLYFSLRKGSLWKILSSFTLLRI

DOR82nt

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CTTCGGAGCAAAGGATAGTGTTCCTTCTTGGAACCATTTGCCAGATATTCCAGATTAC
TGGAGTGCTTATCTATTGGTATTGCAATGGCCGTCTTGCCACGGAAACGGGCACCTTT
GTGGCACAATTATCTGAAATGTGCAGTTCTTTTTGTCTAACATTTGTGGGATTCTGTA
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ATTCATTTAAATTATATTTTTCTTTAAGGAAAGGTAGCCTTTGGAAAATCTTGTCTTC

TTTCACCTTATTGAGGATC

DOR83

MQLEDFMRYPDLVCQAAQLPRYTWNGRRSLEVKRNLAKRIIFWLGAVNLVYHNIGCVM
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LIKHRAYRIHHYQEKYTRHIRNTFIFHTSAVVYYNSLPILLMIREHFSNSQQLGYRIQ
SNTWYPWQVQGSIPGFFAAVACQIFSCQTNMCVNMFIQFLINFFGIQLEIHFDGLARQ
LETIDARNPHAKDQLKYLIVYHTKLLNLADRVNRSFNFTFLISLSVSMISNCFLAFSM
TMFDFGTSLKHLLGLLLFITYNFSMCRSGTHLILTSGKVLPAAFYNNWYEGDLVYRRM
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DOR83nt

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TCTTCTAATGATTCGGGAACATTTCTCGAACTCACAGCAGTTGGGCTATAGAATTCAG
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ACGCCATTTTAGACGCCATGAAAGACAAAAACCTCGGGTTGCACGAATA

DOR84

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HYPDAKQIMPFYQLEPWEFRDSWLFYPSYFHQSSAGYTATCGSIAGDLMIFAVVLQVI
MHYERLAKVLREFKIQAHNAPNGAKEDIRKLQSLVANHIDILRLTDLMNEVFGIPLLL
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DOR84nt

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DOR87

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YPMTLAMFQSLLNASYSYFTMLRGVTGK

DOR87nt

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DOR91

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YIDPRKEPEMFRKVDGKMIINRLVSAMYGAVISLYLIAPVFSIINQSKDFLYSMIFPF
DSDPLYIFVPLLLTNVWVGIVIDTMMFGETNLLCELIVHLNGSYMLLKRDLQLAIEKI
LVARDRPHMAKQLKVLITKTLRKNVALNQFGQQLEAQYTVRVFIMFAFAAGLLCALSF
KAYTTDSLSTMYYLTHWEQILQYSTNPSENLRLLKLINLAIEMNSKPFYVTGLKYFRV
SLQAGLKRQKFLRSASSSTLSTADVLAFAFAFTRWLL

DOR91nt

ATGGTTCGTTACGTGCCCCGGTTCGCTGATGGTCAGAAAGTAAAGTTGGCTTGGCCCT
TGGCGGTTTTTCGGTTAAATCACATATTCTGGCCATTGGATCCGAGCACAGGGAAATG
GGGCCGATATCTGGACAAGGTTCTAGCTGTTGCGATGTCCTTGGTTTTTATGCAACAC
AACGATGCAGAGCTGAGGTACTTGCGCTTCGAGGCAAGTAATCGGAATTTGGATGCCT
TTCTCACAGGAATGCCAACGTATTTAATCCTCGTGGAGGCTCAATTTAGAAGTCTTCA
CATTCTACTGCACTTCGAGAAGCTTCAGAAGTTTTTAGAAATATTCTACGCAAATATT

TATATTGATCCCCGTAAGGAACCCGAAATGTTTCGAAAAGTGGATGGAAAGATGATAA
TTAACAGATTAGTTTCGGCCATGTACGGTGCAGTTATCTCTCTGTATCTAATCGCACC
CGTTTTTTCCATCATTAACCAAAGCAAAGATTTTCTATACTCTATGATCTTTCCGTTC
GATTCGGATCCCTTGTACATATTTGTGCCACTGCTTTTGACAAACGTATGGGTTGGCA
TTGTAATAGATACCATGATGTTCGGGGAGACGAATTTGTTGTGTGAACTAATTGTCCA
CCTAAATGGTAGTTATATGTTGCTCAAGAGGGACTTGCAGTTGGCCATTGAAAAGATA
TTAGTTGCAAGGGACCGTCCGCATATGGCCAAACAGCTAAAGGTTTTAATTACAAAAA
CTCTCCGAAAGAATGTGGCTCTAAATCAGTTTGGCCAGCAGCTGGAGGCTCAGTATAC
TGTGCGGGTTTTTATTATGTTTGCATTCGCTGCGGGCCTTTTATGTGCTCTTTCTTTT
AAGGCTTATACGACGGATTCCCTCAGCACAATGTACTACCTTACCCATTGGGAGCAAA
TCCTGCAGTACTCTACAAATCCCAGCGAAAATCTGCGATTACTAAAGCTCATTAACTT
GGCCATTGAGATGAACAGCAAGCCCTTCTATGTGACAGGGCTAAAATATTTTCGCGTT
AGTCTGCAGGCTGGCTTAAAACGTCAAAAGTTTCTGCGGTCTGCCAGCTCATCCACCC
TTAGCACCGCTGATGTGTTGGCATTTGCTTTTGCTTTTACTCGCTGGCTGCTT

DOR92

MSEWLRFLKRDQQLDVYFFAVPRLSLDIMGYWPGKTGDTWPWRSLIHFAILAIGVATE
LHAGMCFLDRQQITLALETLCPAGTSAVTLLKMFLMLRFRQDLSIMWNRLRGLLFDPN
WERPEQRDIRLKHSAMAARINFWPLSAGFFTCTTYNLKPILIAMILYLQNRYEDFVWF
TPFNMTMPKVLLNYPFFPLTYIFIAYTGYVTIFMFGGCDGFYFEFCAHLSALFEVLQA
EIESMFRPYTDHLELSPVQLYILEQKMRSVIIRHNAIIDLTRFFRDRYTIITLAHFVS
AAMVIGFSMVNLLTLGNNGLGAMLYVAYTVAALSQLLVYCYGGTLVAESSTGLCRAMF
SCPWQLFKPKQRRLVQLLILRSQRPVSMAVPFFSPSLATFAAILQTSGSIIALVKSFQ

DOR92nt

ATGTCCGAGTGGTTACGCTTTCTGAAACGCGATCAACAGCTGGATGTGTACTTTTTTG
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ATGGCCCTGGAGATCCCTGATTCACTTCGCAATCCTGGCCATTGGCGTGGCCACCGAA
CTGCATGCTGGCATGTGTTTTCTAGACCGACAGCAGATTACCTTGGCACTGGAGACCC
TCTGTCCAGCTGGCACATCGGCGGTCACGCTGCTCAAGATGTTCCTAATGCTGCGCTT
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TGGGAGCGACCCGAGCAGCGGGACATCCGGCTAAAGCACTCGGCCATGGCGGCTCGCA
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CCTACATATTTATTGCCTATACGGGCTATGTGACCATCTTTATGTTCGGCGGCTGTGA
TGGTTTTTATTTCGAGTTCTGTGCCCACCTATCAGCTCTTTTCGAAGTGCTCCAGGCG
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TTTGACCAGATTTTTTCGTGATCGCTATACCATTATTACCCTGGCCCATTTTGTGTCC
GCCGCCATGGTGATTGGATTCAGCATGGTTAATCTCCTGACATTGGGCAATAATGGTC
TGGGCGCAATGCTCTATGTGGCCTACACGGTTGCCGCTTTGAGCCAACTGCTGGTTTA
TTGCTATGGCGGAACTCTGGTGGCCGAAAGTAGCACTGGTCTGTGCCGAGCCATGTTC
TCCTGTCCGTGGCAGCTTTTTAAGCCTAAACAACGTCGACTCGTTCAGCTTTTGATTC
TCAGATCGCAGCGTCCTGTTTCCATGGCAGTGCCATTCTTTTCGCCATCGTTGGCTAC
CTTTGCTGCGATTCTTCAAACTTCGGGTTCCATAATTGCGCTGGTTAAGTCCTTTCAG

DOR95

MSDKVKGKKQEEKDQSLRVQILVYRCMGIDLWSPTMANDRPWLTFVTMGPLFLFMVPM
FLAAHEYITQVSLLSDTLGSTFASMLTLVKFLLFCYHRKEFVGLIYHIRAILAKEIEV
WPDAREIIEVENQSDQMLSLTYTRCFGLAGIFAALKPFVGIILSSIRGDEIHLELPHN
GVYPYDLQVVMFYVPTYLWNVMASYSAVTMALCVDSLLFFFTYNVCAIFKIAKHRMIH
LPAVGGKEELEGLVQVLLLHQKGLQIADHIADKYRPLIFLQFFLSALQICFIGFQVAD
LFPNPQSLYFIAFVGSLLIALFIYSKCGENIKSASLDFGNGLYETNWTDFSPPTKRAL
LIAAMRAQRPCQMKGYFFEASMATFSTIVRSAVSYIMMLRSFNA

DOR95nt

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CTACAACGTGTGCGCCATTTTCAAGATCGCCAAGCACCGGATGATCCATCTGCCGGCG
GTGGGCGGAAAGGAGGAGCTGGAGGGGCTCGTCCAGGTGCTGCTGCTGCACCAGAAGG
GCCTCCAGATCGCCGATCACATTGCGGACAAGTACCGGCCGCTGATCTTTTTGCAGTT
CTTTCTGTCCGCCTTGCAGATCTGCTTCATTGGATTCCAGGTGGCTGATCTGTTTCCC
AATCCGCAGAGTCTCTACTTTATCGCCTTTGTGGGCTCGCTGCTCATCGCACTGTTCA
TCTACTCGAAGTGCGGCGAAAATATCAAGAGTGCCAGCCTGGATTTCGGAAACGGGCT
GTACGAGACCAACTGGACCGACTTCTCGCCACCCACTAAAAGAGCCCTCCTCATTGCC
GCCATGCGCGCCCAGCGACCTTGCCAGATGAAGGGCTACTTTTTCGAGGCCAGCATGG
CCACCTTCTCGACGATTGTTCGCTCTGCCGTGTCGTACATCATGATGTTGCGCTCCTT
TAATGCC

DOR99

MEEFLRPQMFQEVAQMVHFQWRRNPVDNSMVNASMVPFCLSAFLNVLFFGCNGWDIIG
HFWLGHPANQNPPVLSITIYFSIRGLMLYLKRKEIVEFVNDLDRECPRDLVSQLDMQM
DETYRNFWQRYRFIRIYSHLGGPMFCVVPLALFLLTHEGKDTPVAQHEQLLGGWLPCG
VRKDPNFYLLVWSFDLMCTTCGVSFFVTFDNLFNVMQGHLVMHLGHLARQFSAIDPRQ

SLTDEKRFFVDLRLLVQRQQLLNGLCRKYNDIFKVAFLVSNFVGAGSLCFYLFMLSET
SDVLIIAQYILPTLVLVGFTFEICLRGTQLEKASEGLESSLRSQEWYLGSRRYRKFYL
LWTQYCQRTQQLGAFGLIQVNMVHFTEIMQLAYRLFTFLKSH

DOR99nt

ATGGAGGAGTTTCTGCGTCCGCAGATGTTCCAGGAGGTGGCTCAGATGGTGCATTTCC
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CTTGTCGGCGTTTCTTAATGTCCTGTTTTTCGGCTGCAATGGTTGGGACATCATAGGA
CATTTTTGGCTGGGACATCCTGCCAACCAGAATCCGCCCGTGCTTAGCATCACCATTT
ACTTCTCGATCAGGGGATTGATGCTATACCTGAAACGAAAGGAAATCGTTGAGTTTGT
TAACGACTTGGATCGGGAGTGTCCGCGGGACTTGGTCAGCCAGTTGGACATGCAAATG
GATGAGACGTACCGAAACTTTTGGCAGCGCTATCGCTTCATCCGTATCTACTCCCATT
TGGGTGGTCCGATGTTCTGCGTTGTGCCATTAGCTCTATTCCTCCTGACCCACGAGGG
TAAAGATACTCCTGTTGCCCAGCACGAGCAGCTCCTTGGAGGATGGCTGCCATGCGGT
GTGCGAAAGGACCCAAATTTCTACCTTTTAGTCTGGTCCTTCGACCTGATGTGCACCA
CTTGCGGCGTCTCCTTTTTCGTTACCTTCGACAACCTATTCAATGTGATGCAGGGACA
TTTGGTCATGCATTTGGGCCATCTTGCTCGCCAGTTTTCGGCCATCGATCCTCGACAG
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TCAGATGTCCTTATCATCGCCCAGTATATATTACCCACTTTGGTCCTGGTGGGCTTCA
CATTTGAGATTTGTCTACGGGGAACCCAACTGGAAAAGGCGTCGGAGGGACTGGAATC
GTCGTTGCGAAGCCAGGAATGGTATTTGGGAAGTAGGCGGTACCGGAAGTTCTATTTG
CTCTGGACGCAATATTGCCAGCGAACACAGCAACTGGGCGCCTTTGGGCTAATCCAAG
TCAATATGGTGCACTTCACTGAAATAATGCAGCTGGCCTATAGACTCTTCACTTTTCT
CAAATCTCAT

DORA45

MTTSMQPSKYTGLVADLMPNIRAMKYSGLFMHNFTGGSAFMKKVYSSVHLVFLLMQFT
FILVNMALNAEEVNELSGNTITTLFFTHCITKFIYLAVNQKNFYRTLNIWNQVNTHPL
FAESDARYHSIALAKMRKLFFLVMLTTVASATAWTTITFFGDSVKMVVDHETNSSIPV
EIPRLPIKSFYPWNASHGMFYMISFAFQIYYVLFSMIHSNLCDVMFCSWLIFACEQLQ
HLKGIMKPLMELSASLDTYRPNSAALFRSLSANSKSELIHNEEKDPGTDMDMSGIYSS
KADWGAQFRAPSTLQSFGGNGGGGNGLVNGANPNGLTKKQEMMVRSAIKYWVERHKHV
VRLVAAIGDTYGAALLLHMLTSTIKLTLLAYQATKINGVNVYAFTVVGYLGYALAQVF
HFCIFGNRLIEESSSVMEAAYSCHWYDGSEEAKTFVQIVCQQCQKAMSISGAKFFTVS
LDLFASVLGAVVTYFMVLVQLK

DORA45nt

GGCACGAGCTGGTTCCGGAAAGCCTCATATCTCGTATCTTAAAGTATCCCGGTTAAGC
CTTAAAGAGTGAAATGATTGCCTAGACGATTGCTGCATTACTGGCACTCAATTAACCC
AAGTGTACCAGACAACAATTACATTTGTATTTTTAAAGTTCAATAGCAAGGATGACAA
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GGCGATGAAGTACTCCGGCCTGTTCATGCACAACTTCACGGGCGGCAGTGCCTTCATG
AAGAAGGTGTACTCCTCCGTGCACCTGGTGTTCCTCCTCATGCAGTTCACCTTCATCC
TGGTCAACATGGCCCTGAACGCCGAGGAGGTCAACGAGCTGTCGGGCAACACGATCAC
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AATTTCTACAGAACATTGAATATATGGAACCAGGTGAACACGCATCCCTTGTTCGCCG
AGTCGGATGCTCGTTACCATTCGATCGCACTGGCGAAGATGAGGAAGCTGTTCTTTCT
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GACAGCGTAAAAATGGTGGTGGACCATGAGACGAACTCCAGCATCCCGGTGGAGATAC
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GAAGAAAAGGATCCCGGCACCGACATGGACATGTCGGGCATCTACAGCTCGAAAGCGG
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CGGAGGCAACGGGTTGGTGAACGGCGCTAATCCCAACGGGCTGACCAAAAAGCAGGAG
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TGGTGGCTGCCATCGGCGATACTTACGGAGCCGCCCTCCTCCTCCACATGCTGACCTC
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TACGCCTTCACAGTCGTCGGATACCTAGGATACGCGCTGGCCCAGGTGTTCCACTTTT
GCATCTTTGGCAATCGTCTGATTGAAGAGAGTTCATCCGTCATGGAGGCCGCCTACTC
GTGCCACTGGTACGATGGCTCCGAGGAGGCCAAGACCTTCGTCCAGATCGTGTGCCAG
CAGTGCCAGAAGGCGATGAGCATATCGGGAGCGAAATTCTTCACCGTCTCCCTGGATT
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GTAAGTTGCTGCGAAGCTGATGGATTTTTGTACCAGAAAAGCGAATGCCAAGAAGCCA
CCTACCGCCCCTTGCCCCCTCCGCACTGTGCAACCAGCAATATCACAGAGCAATTATA
ACGCAAATTATATATTTTATACCTGCGACGAGCGAGCCTCGTGGGGCATAATGGAGAC
ATTCTGGGGCACATAGAAGCCTGCAAATACTTATCGATTTTGTACACGCGTAGAGCTT
TTAATGTAAACTCAAGATGCAAACTAAATAAATGTGTAGTGAAAAAAAAAAAAAAAAA
AAA

GENBANK ACCESSION NUMBERS

The accession numbers for the sequences reported in this paper are AF127921-AF127926.

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